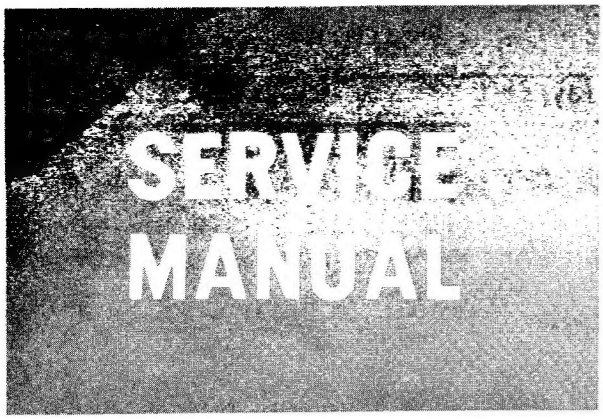


DATSUN PICK-UP
MODEL 620 SERIES
CHASSIS & BODY

NISSAN

NISSAN MOTOR CO., LTD.
TOKYO, JAPAN

SECTION EM

EM

ENGINE MECHANICAL

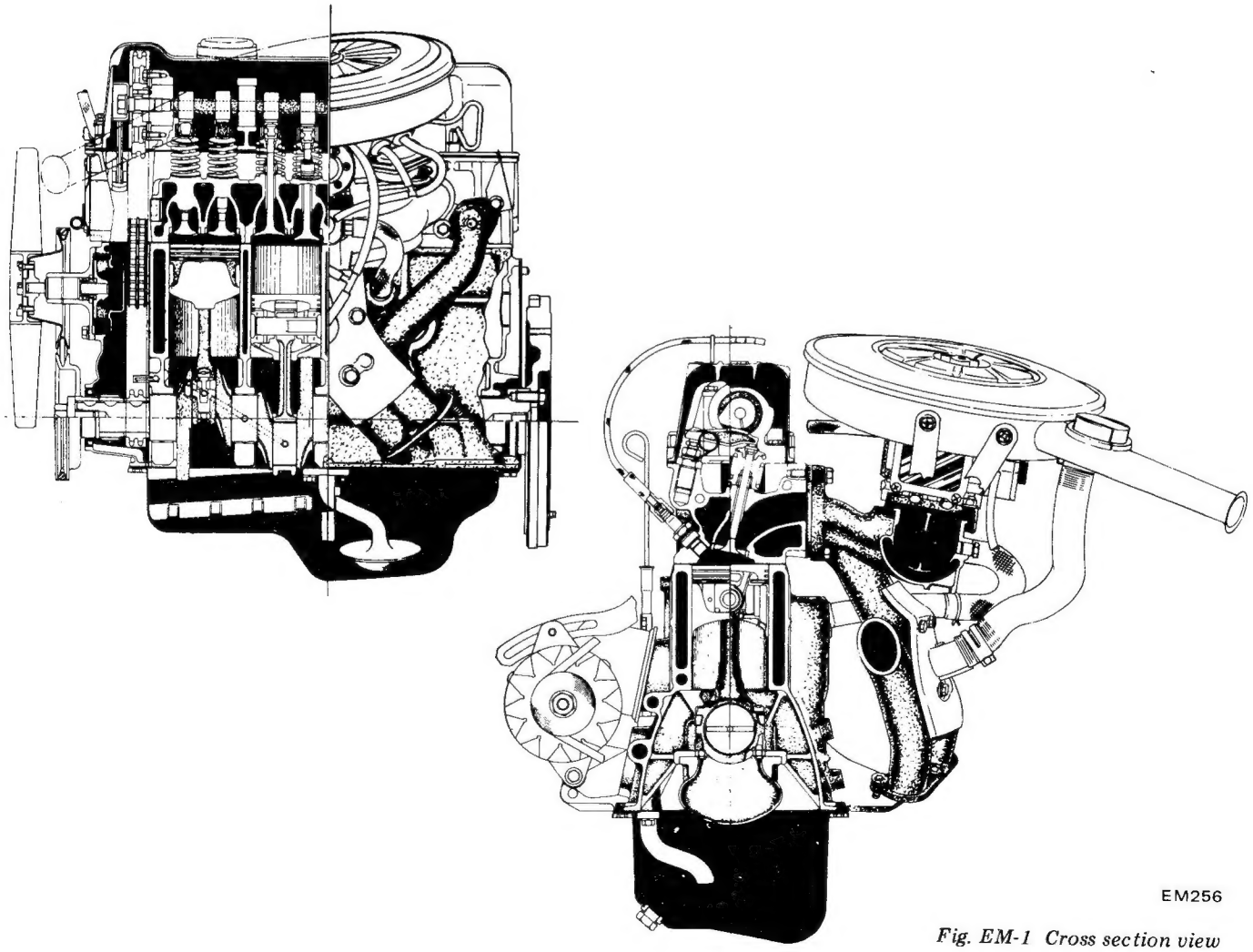
GENERAL DESCRIPTION

CONTENTS

L16 AND L18 ENGINES

The L16 and L18 engines feature O.H.C. valves, wedge-shaped combustion chamber, alminum heads and fully balanced 5-bearing crankshaft to turn out smooth, dependable power. The cylinder block is cast in a single unit, featuring deep skirting.

These engines are equipped with a single, 2-barrel, downdraft carburetor that incorporates a special device to control emissions.



EM256

Fig. EM-1 Cross section view

Main specifications

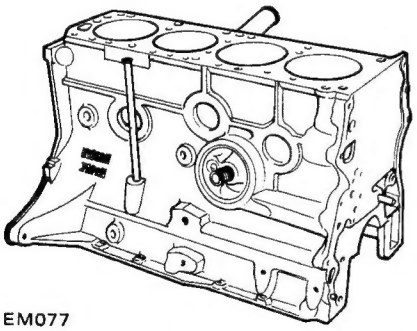
		L16	L18
Displacement	cc (cu in)	1,595 (97.33)	1,770 (108.01)
Bore x stroke	mm (in)	83 x 73.7 (3.268 x 2.902)	85 x 78 (3.346 x 3.071)
Compression ratio		8.5	←
Ignition timing for M/T B.T.D.C. (for A/T)		5°/800 rpm (Retarded side) 5°/650 rpm in "D" range (Retarded side)	←

M/T: Manual Transmission A/T: Automatic Transmission

CYLINDER BLOCK

The cylinder block, which is of a monoblock special casting structure, adopts five-bearing-support system for quietness and higher durability.

The cylinder bores are surrounded by cooling jackets and machined directly in the block. The oil ways in the block are arranged so that the full-flow oil filter is directly attached to the right hand side of the block.



EM077

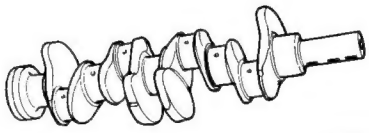
Fig. EM-2 Cylinder block

CRANKSHAFT

The crankshaft is a special steel forging. Fully balanced, it turns out smooth, dependable power at high speed.

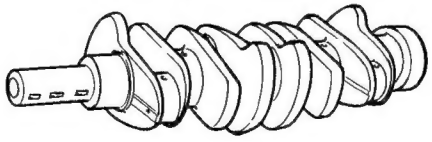
The L18 engine uses eight balance weights, while the others use four.

Main bearings gain lubrication from oil pumped through the main oil gallary and the oil holes which run in parallel with cylinder bores. There are drilled oilways in the crankshaft for the lubricating oil. The center main bearing is equipped with thrust washers to take up end thrust of the crankshaft.



EM078

Fig. EM-3 Crankshaft (L16)



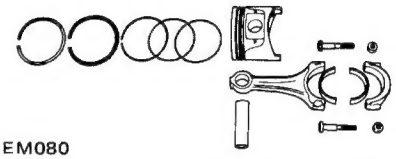
EM079

Fig. EM-4 Crankshaft (L18)

PISTON AND CONNECTING ROD

The pistons are special alminum casting with struts to control thermal expansion and have two compression rings and one combined oil ring. The piston heads are slightly dished. The piston pin is a special hollow steel shaft. It is full-floating fit to the piston and press fit to the connecting rods.

The connecting rods are special forged steel. Oil is sprayed to the connecting rod small ends through drilled passages in the large ends of rod. Oil holes in the connecting rods are located so as to insure optimum lubrication under heavy load.

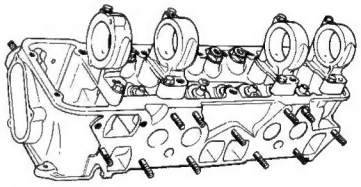


EM080

Fig. EM-5 Piston and connecting rod

CYLINDER HEAD

The cylinder head is made of light and strong aluminum alloy with good cooling efficiency; it contains wedge type combustion chambers. A special aluminum bronze valve seat is used on the intake valve, while a heat resistant steel valve seat is installed on the exhaust valve. These parts are all hot press-fitted.



EM081

Fig. EM-6 Cylinder head

CAMSHAFT

Camshaft is made of special cast iron and located inside rocker cover. Four aluminum alloy brackets support camshaft. Camshaft bearings are lubricated from oil holes which lead to the main oil gallery of the cylinder head.

The concentric passages are drilled in the front and rear part of the camshaft.

The oil to each cam lobe is supplied through an oil hole drilled in the base

circle of each lobe. Lubricant is supplied to the front oil gallery from 2nd camshaft bearing and to the rear oil gallery from 3rd camshaft bearing. These holes on the base circle of lobe supply lubricant to the cam pad surface of the rocker arm and to the valve tip end. The cams feature a long-overlap profile to reduce NOx emission.

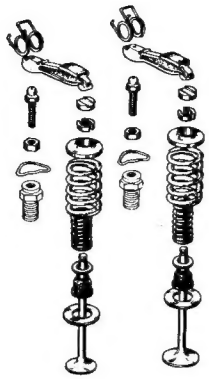


Fig. EM-8 Valve mechanism

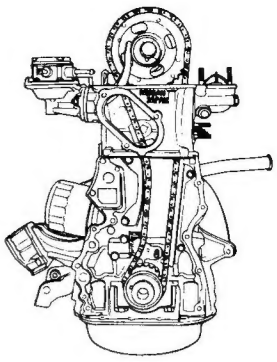


Fig. EM-9 Chain driving system

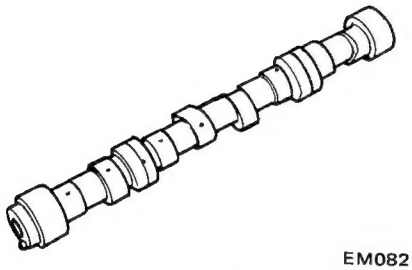


Fig. EM-7 Camshaft

MANIFOLDS

The intake manifold is made of casted aluminum alloy.

The exhaust manifold, identical in design on both engine types is a dual exhaust system intended to prevent decrease in output due to exhaust interference and to increase output through the inertia scavenging action. It is connected to exhaust pipes by flanges, which insure complete absence of exhaust leaks.

VALVE MECHANISM

The valve system has a pivot type rocker arm that is activated directly by the cam mechanism, and this has made its moving parts considerably lighter and provides an ideal highspeed performance.

Dual type valve springs are equipped.

CAMSHAFT DRIVE

Camshaft is driven by a double row roller chain driven by crankshaft. The tension of the chain is controlled by a chain tensioner which is operated by spring and oil pressure. The rubber shoe type tensioner insulates vibration of the chain and controls tension of the chain.

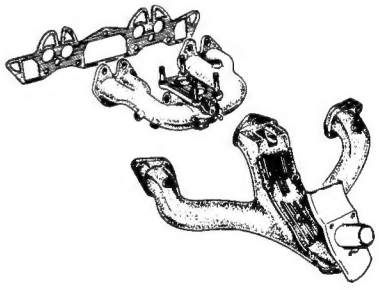


Fig. EM-10 Manifolds

ENGINE DISASSEMBLY

CONTENTS

PRELIMINARY CLEANING AND INSPECTION

Before disassembling engine, observe the following items:

1. Fuel, oil or water may leak past cylinder head and block. Prior to disassembling, check cylinder head, front chain cover, oil pan and oil filter gaskets and crankshaft and water pump seals for sign of leak past their gasketed surfaces.

2. Check carburetor and fuel pump for condition; fuel hoses for deterioration, cracks or otherwise leakage of fuel past their jointed or connected surfaces.
3. Remove air cleaner, alternator, distributor and starter, and plug up carburetor air-horn and distributor hole to prevent entry of foreign matter.
4. Wipe dust and mud off engine.
5. Inspect block, rocker cover, front chain cover, oil pan and all other outer parts for visual defects and broken or missing parts such as bolts and nuts.
6. Test all pipings and electrical circuits for discontinuity or broken or damaged insulation.

DISASSEMBLY

To remove engine from car, refer to relative topic under "Engine Removal and Installation" in Chassis and Body Service Manual, Section ER.

1. Remove transmission from engine.
2. Thoroughly drain engine oil and coolant by removing drain plugs.
3. Place engine assembly on the engine stand.
   (1) Remove fan and fan pulley.
   (2) Remove engine mounting R.H.
   (3) Remove oil filter using special tool "Oil Filter Wrench ST19320000."
   (4) Remove oil pressure switch.
   (5) Install engine attachment to cylinder block using bolt holes securing alternator bracket and water drain plug.
   (6) Set engine on the stand.

"Engine Attachment ST05260001"
"Engine Stand ST0501S000"

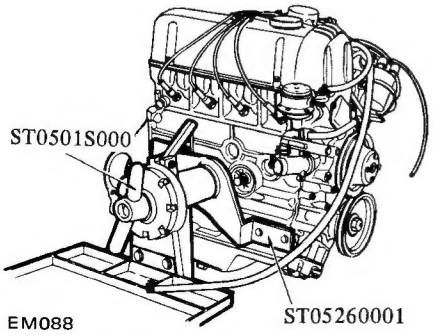


Fig. EM-11 Engine on engine stand

4. Remove oil level gauge.
5. Remove clutch assembly.
6. Remove high tension cable.
7. Remove spark plugs.
8. Remove thermostat housing.

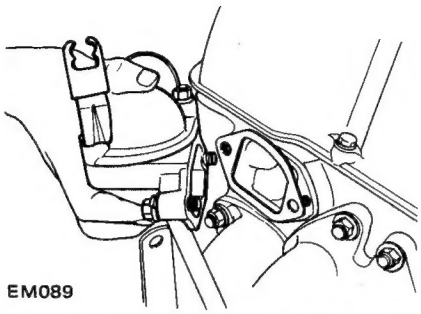


Fig. EM-12 Removing thermostat housing

9. Remove rocker cover.
10. Remove carburetor.
11. Remove intake and exhaust manifolds.

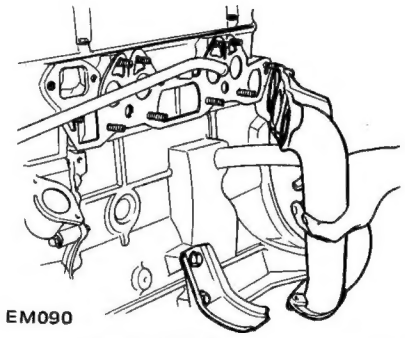


Fig. EM-13 Removing manifolds

12. Remove engine mounting L.H.
13. Remove crank pulley.
14. Remove water pump.
15. Remove fuel pump.
16. Remove fuel pump drive cam.
17. Remove camshaft sprocket.

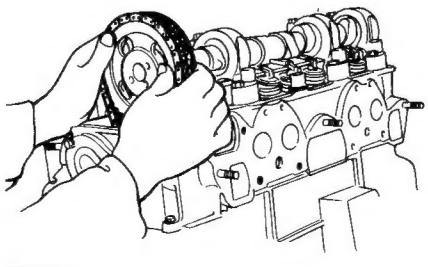


Fig. EM-14 Removing camshaft sprocket

18. Remove cylinder head assembly. Use special tool "Cylinder Head Bolt Wrench ST10120000" to remove cylinder head bolts. Loosen bolts from ① to ⑩ as shown in Figure EM-15.

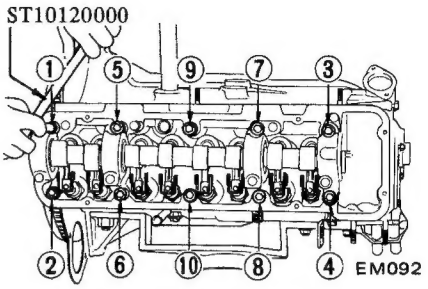


Fig. EM-15 Cylinder head bolt loosening sequence

Note: For the convenience of cylinder head replacement, special tool "Chain Stopper ST17420001" is prepared to support timing chain during the service operation. By using this tool, timing marks on crankshaft sprocket and timing chain will be unchanged. So the work for aligning timing marks will be saved so much.

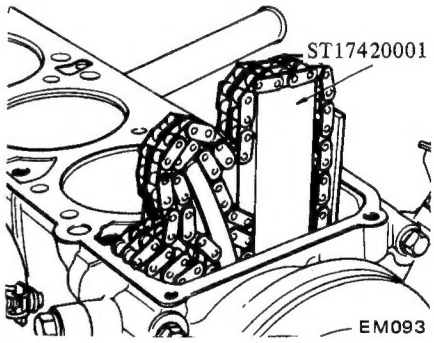


Fig. EM-16 Supporting timing chain

19. Invert engine.
20. Remove oil pan and oil strainer.

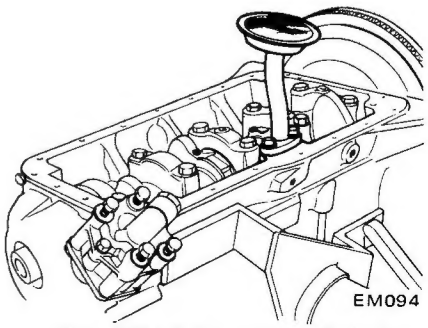


Fig. EM-17 Removing oil strainer and oil pump

21. Remove oil pump and its drive spindle.
22. Remove front cover.
23. Remove chain tensioner.

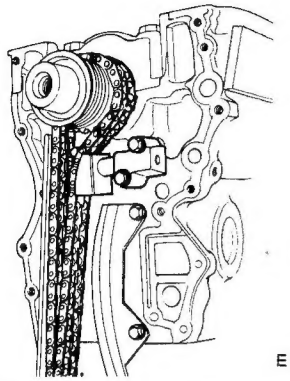


Fig. EM-18 Removing chain tensioner and timing chain

24. Remove timing chain.
25. Remove oil thrower, crankshaft worm gear and chain drive sprocket.

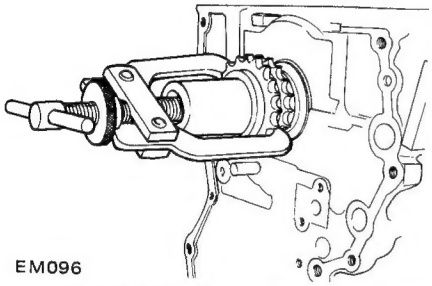


Fig. EM-19 Removing chain drive sprocket

26. Remove piston and connecting rod assembly. Take off connecting rod bearings and keep them in order.

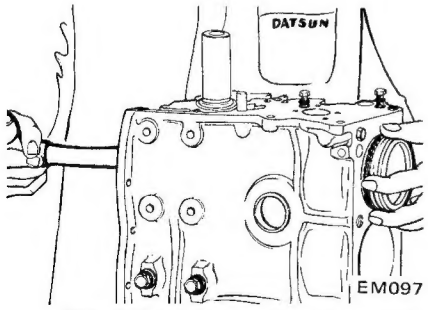


Fig. EM-20 Removing piston and connecting rod assembly

27. Remove flywheel. Be careful not to drop it.

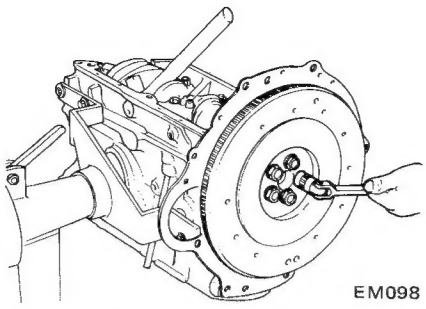


Fig. EM-21 Removing flywheel

28. Remove main bearing caps.
Use special tool "Crankshaft Main Bearing Cap Puller ST1651S000" to remove center and rear main bearing caps. Keep them in order.

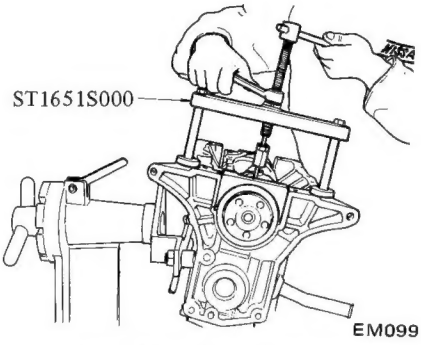


Fig. EM-22 Removing rear main bearing cap

29. Remove rear oil seal.

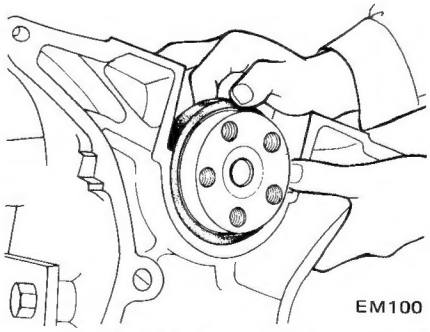


Fig. EM-23 Removing rear oil seal

30. Remove crankshaft.
31. Remove buffle plate and cylinder block net.

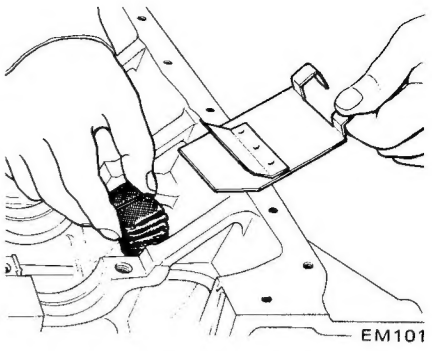


Fig. EM-24 Removing buffle plate and net

PISTONS AND CONNECTING RODS

1. Remove piston rings with a ring remover.

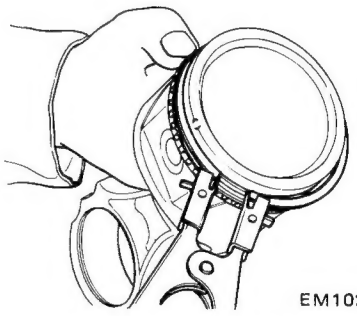


Fig. EM-25 Removing piston ring

2. Press out piston pin with special tool "Piston Pin Press Stand ST13030001."

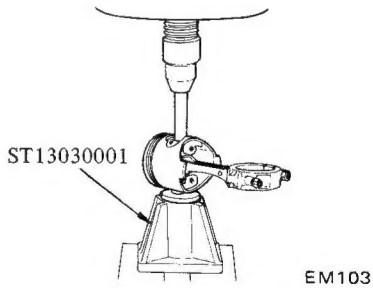


Fig. EM-26 Removing piston pin

3. Keep the disassembled parts in order.

CYLINDER HEAD

1. Loosen valve rocker pivot lock nut and remove rocker arm by pressing down valve spring.

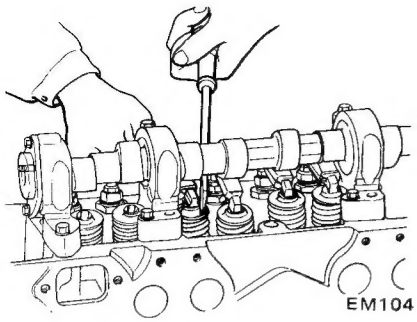


Fig. EM-27 Removing rocker arm

Note: Take care not to lose valve rocker guide.

2. Remove camshaft.

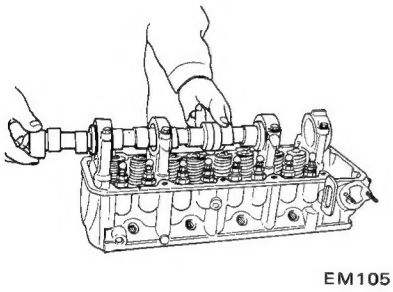


Fig. EM-28 Removing camshaft

Note: At this time, take care not to damage camshaft bearings and cam lobes.

3. Remove valves using special tool "Valve Lifter ST12070000."

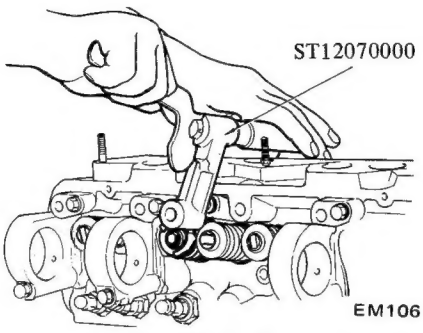


Fig. EM-29 Removing valve

4. Take care not to lose valve spring seat, oil seal, valve collet, and valve rocker guide.

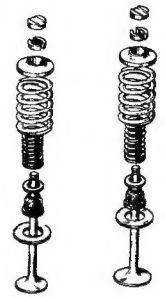


Fig. EM-30 Valve components

Note: Be sure to leave camshaft bearing intact. Because the bearing center is liable to be out of alignment.

INSPECTION AND REPAIR

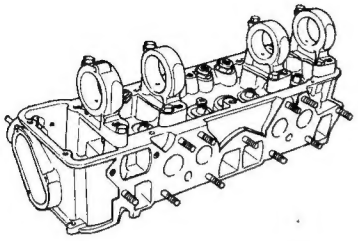
CONTENTS

PREPARATION FOR INSPECTION

1. Before cleaning, check for sign of water and oil leaks in cylinder block and head.
2. Clean oil, carbon deposits and sealant from all parts. Remove gasket.
3. Clean all oil holes with solvent and dry with compressed air. Make sure that they are not restricted.

CYLINDER HEAD AND VALVE

Checking cylinder head mating face

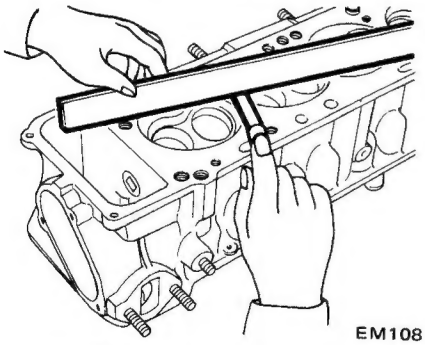


EM081

Fig. EM-31 Cylinder head

Note: Never remove camshaft bearings unless you have a suitable machine for boring camshaft bearing in line. If you once remove camshaft bearings, bearing centers will be out of alignment and reconditioning is very difficult without center borings.

1. Make a visual check for cracks and flaws.
2. Measure the surface of cylinder head (on cylinder block side) for warpage. If it is found to be beyond the limit designated below, regrind the affected surface with a surface grinder.



EM108

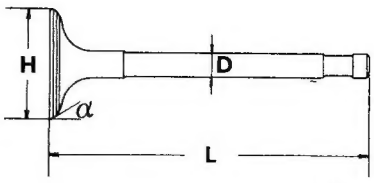
Fig. EM-32 Checking cylinder head surface

Head surface flatness

Standard	Maximum
less than 0.05 mm (0.0020 in)	0.1 mm (0.0039 in)

Valve assembly

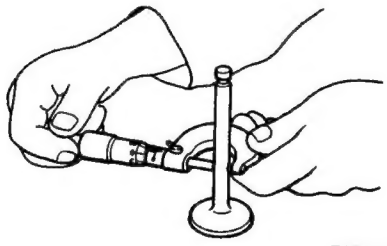
1. Check each of the intake and exhaust valve for worn, damaged or deformed valve caps or stems. Correct or replace the valve that is defective.
2. Valve face or valve stem end surface should be refaced by using a valve grinder.



EM109

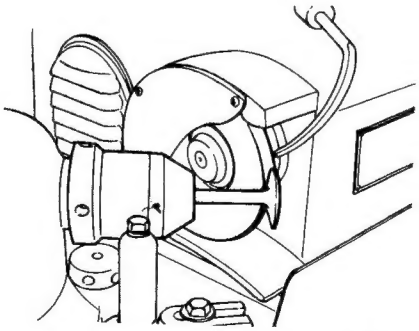
Fig. EM-33 Intake and exhaust valve dimensions

H	Valve head diameter mm (in)	L16	In.	42.0 to 42.2 (1.654 to 1.661)
			Ex.	33.0 to 33.2 (1.299 to 1.307)
		L18	In.	42.0 to 42.2 (1.654 to 1.661)
			Ex.	35.0 to 35.2 (1.378 to 1.386)
L	Valve length mm (in)	L16 L18	In.	114.9 to 115.2 (4.524 to 4.535)
			Ex.	115.7 to 116.0 (4.555 to 4.567)
D	Valve stem diameter mm (in)	L16 L18	In.	7.965 to 7.980 (0.3136 to 0.3142)
			Ex.	7.945 to 7.960 (0.3128 to 0.3134)
α	Valve seat angle In. & Ex.			45°30′



EM110

Fig. EM-34 Checking valve stem diameter



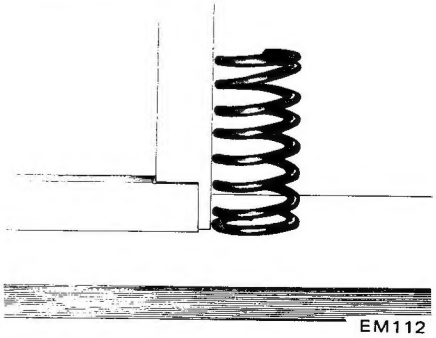
EM111

Fig. EM-35 Regrinding valve face

Note: When valve head has been worn down to 0.5 mm (0.0197 in) in thickness, replace the valve.
Grinding allowance for the valve stem end surface is 0.5 mm (0.0197 in) or less.

Valve spring

1. Check valve spring for squareness using a steel square and surface plate. If spring is out of square more than 1.6 mm (0.063 in), replace with a new one.
2. Measure the free length and the tension of each spring. If the measured value exceeds the specified limit, replace spring.



EM112

Fig. EM-36 Measuring spring squareness

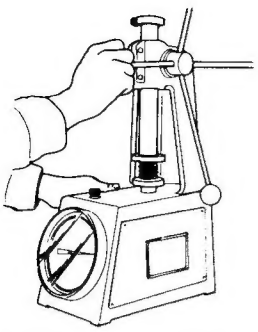


Fig. EM-37 Measuring spring tension

Spring specifications

		L16 and L18
Valve spring free length	mm (in)	
Intake	Outer	49.98 (1.968)
	Inner	44.85 (1.766)
Exhaust	Outer	49.98 (1.968)
	Inner	44.85 (1.766)
Valve spring pressured length (valve open)	mm/kg (in/lb)	
Intake	Outer	29.5/49.0 (1.161/108)
	Inner	24.5/25.5 (0.965/56.2)
Exhaust	Outer	29.5/49.0 (1.161/108)
	Inner	24.5/25.5 (0.965/56.2)
Valve spring assembled height (valve close)	mm/kg (in/lb)	
Intake	Outer	40.0/21.3 (1.575/47.0)
	Inner	35.0/12.3 (1.378/27.1)
Exhaust	Outer	40.0/21.3 (1.575/0.839)
	Inner	35.0/12.3 (1.378/0.484)

Rocker arm and valve rocker pivot

Check pivot head and cam contact and pivot contact surfaces of rocker arm for damage or wear. If defects are found, replace them. A defective pivot necessitates its replacement together with the corresponding rocker arm.

Valve guide

Measure the clearance between valve guide and valve stem. If the clearance exceeds the designated limit, replace the worn parts or both valve and valve guide. In this case, it is essential to determine if such a clearance has been caused by a worn or bent valve stem or by a worn valve guide.

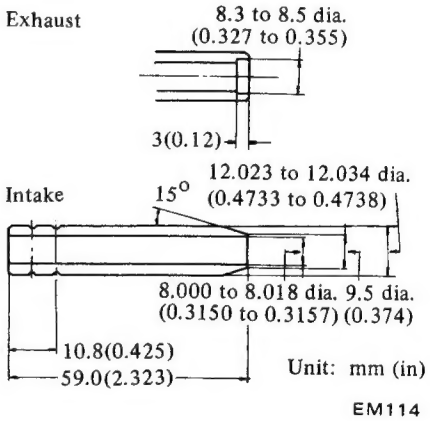


Fig. EM-38 Standard valve guide

		Intake valve	Exhaust valve
Stem to guide clearance mm (in)	L16, L18	0.020 to 0.053 (0.0008 to 0.0021)	0.040 to 0.073 (0.0016 to 0.0029)
Max. tolerance of above clearance mm (in)	L16, L18	0.1 (0.0039)	

As an emergency expedient, a valve is pushed in valve guide and moved to the left and the right at which point if its tip deflects about 0.2 mm (0.0079 in) or more, it will be known that the clearance between stem and guide exceeds the maximum limit of 0.1 mm (0.0039 in).

Note: Valve should be moved in parallel with rocker arm. (Generally, a large amount of wear occurs in this direction.)

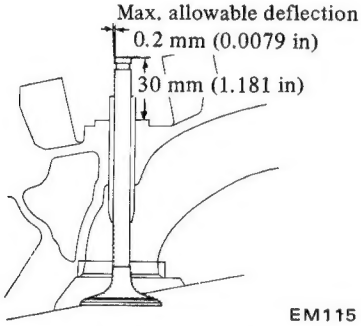


Fig. EM-39 Measuring clearance between valve stem and valve guide

Replacement of valve guide

1. To remove old guides, use a drift and a press (under a 2-ton pressure) or a hammer.

Drive them out from combustion chamber side toward rocker cover. Heated cylinder head will facilitate the operation.

2. Ream cylinder head side guide hole at room temperature.

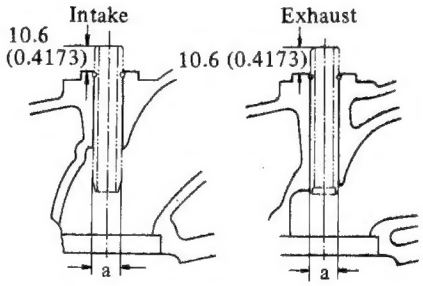


Fig. EM-40 Valve guide hole

		L16 and L18
Guide hole inner diameter "a" mm (in)	For standard valve guide	11.985 to 11.996 (0.4719 to 0.4723)
	For service valve guide	12.185 to 12.196 (0.4797 to 0.4802)

3. Press new valve guide into valve carefully so that it will fit smoothly after heating cylinder head to 150° to 200°C (302° to 392°F).

Valve guide of 0.2 mm (0.0079 in) oversize diameter is available for service.

	L16 and L18
Interference fit of valve guide to guide hole mm (in)	0.027 to 0.049 (0.0011 to 0.0019)

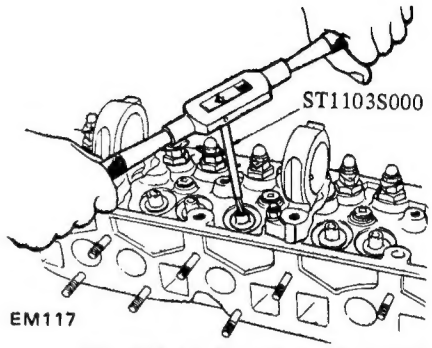


Fig. EM-41 Reaming valve guide

4. Ream the bore with valve guide pressed in, using special tool "Valve Guide Reamer Set ST1103S000."

Reaming bore:
8.000 to 8.018 mm
(0.3150 to 0.3157 in)

5. Correct valve seat surface with new valve guide as the axis.

Valve seat inserts

Check valve seat inserts for any evidence of pitting at valve contact surface, and reseat or replace if worn out excessively.

Valve seat insert of 0.5 mm (0.0197 in) oversize is available for service in this L series engine.

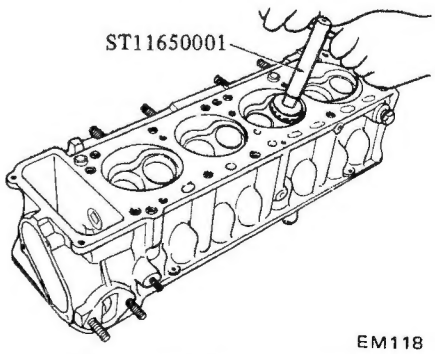


Fig. EM-42 Correcting valve seat

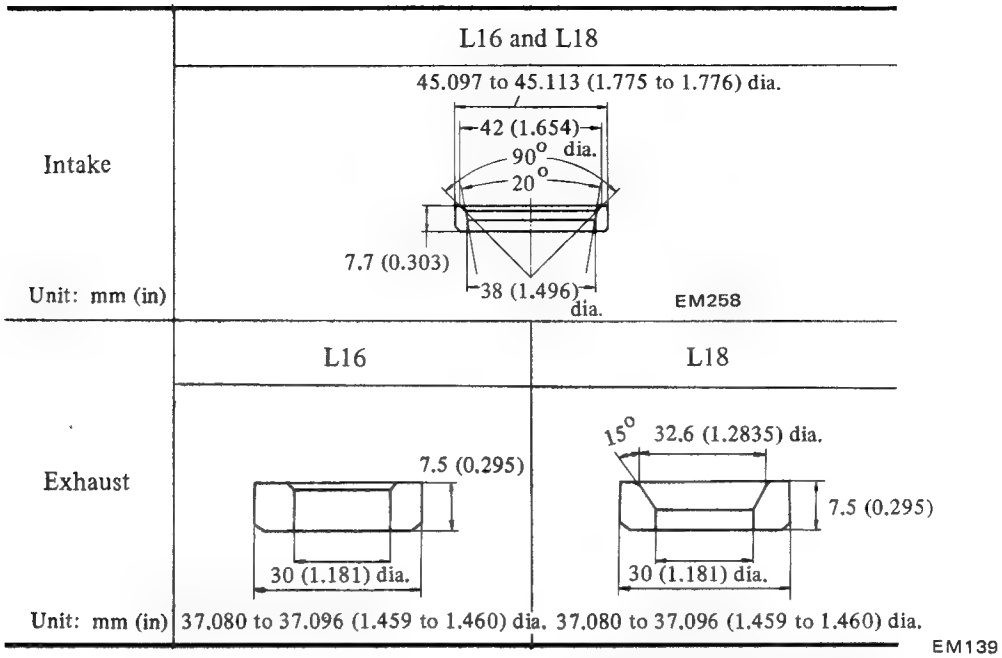


Fig. EM-43 Standard valve seat dimensions

Cylinder head recess diameter

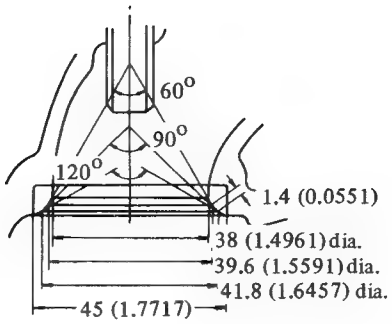
Unit: mm (in)

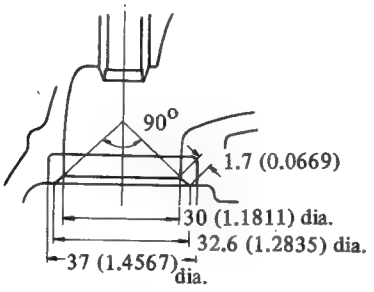
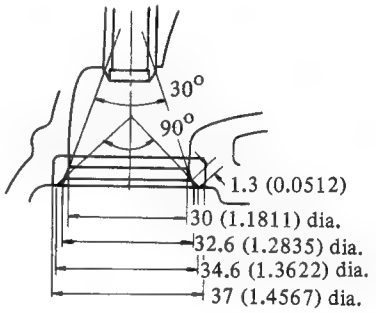
		L16 and L18
Intake	For factory standard insert	45.000 to 45.016 (1.7717 to 1.7723)
	For service insert	45.500 to 45.516 (1.7913 to 1.7920)
Exhaust	For factory standard insert	37.000 to 37.016 (1.4567 to 1.4573)
	For service insert	37.500 to 37.516 (1.4764 to 1.4770)

Interference fit mm (in)	Intake	0.081 to 0.113 (0.0032 to 0.0044)
	Exhaust	0.064 to 0.096 (0.0025 to 0.0038)

Replacing valve seat insert

1. Old insert can be removed by boring out until it collapses. The machine depth stop should be set so that boring cannot continue beyond the bottom face of the insert recess in cylinder head.
2. Select a suitable valve seat insert and check its outside diameter.
3. Machine cylinder head recess to the concentric circles to valve guide center so that insert will have the correct fit.
4. Ream the cylinder head recess at room temperature.
5. Heat cylinder head to a temperature of 150° to 200°C (302° to 392°F).
6. Fit insert ensuring that it beds on the bottom face of its recess, and caulk more than 4 points.
7. Valve seats newly fitted should be cut or ground at the specified dimensions as shown in Figure EM-44.
8. Apply small amount of fine grinding compound to valve contacting face and put valve into guide. Lap valve against its seat until proper valve seating is obtained. Remove valve and then clean valve and valve seat.

	L16 and L18
Intake Unit: mm (in)	

	L16	L18
Exhaust Unit: mm (in)		

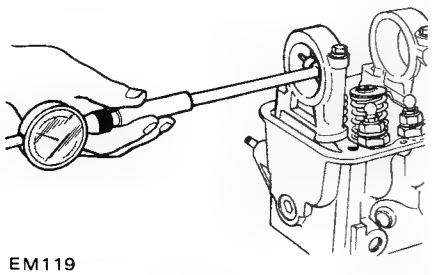
EM121

Fig. EM-44 Valve seat dimensions

CAMSHAFT AND CAMSHAFT BEARING

Camshaft bearing clearance

Measure the inside diameter of camshaft bearing with an inside dial gauge and the outside diameter of camshaft journal with a micrometer. If wear is found inside bracket, replace cylinder head assembly.



EM119

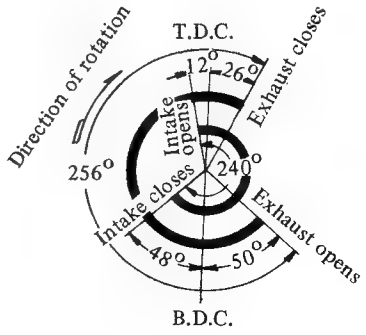
Fig. EM-45 Checking camshaft bearing

Camshaft journal to bearing clearance

	Standard	Wear limit
Oil clearance mm (in)	0.038 to 0.067 (0.0015 to 0.0026)	0.1 (0.0039)
Inner diameter of cam shaft bearing mm (in)	48.000 to 48.016 (1.8898 to 1.8904)	—

Valve timing

This diagram will apply to all cylinders. If any valve is found "out of specifications," one possibility is that cam lobe is worn or damaged, calling for replacement of camshaft.



EM259

Fig. EM-46 Valve timing diagram

	Standard	Bend limit
Camshaft bend mm (in)	0.02 (0.0008)	0.05 (0.0020)

Camshaft alignment

1. Check camshaft, camshaft journal and cam surface for bend, wear or damage. If defects are beyond the limits, replace the affected parts.
2. A bend valve is one-half of the reading obtained when camshaft is turned one full revolution with a dial gauge to 2nd and 3rd journals.

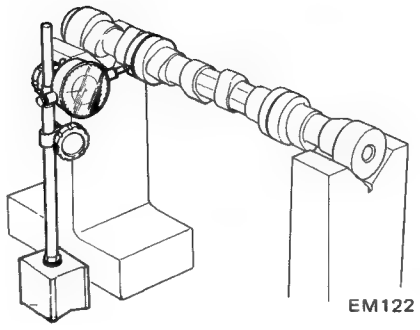


Fig. EM-47 Checking camshaft bend

		L16 and L18
Standard height of cam mm (in)	Intake	39.95 to 40.00 (1.5728 to 1.3748)
	Exhaust	
Wear limit of cam height mm (in)		0.25 (0.0098)
Allowable difference in diameter between max. worn and min. worn parts of camshaft journal mm (in)		0.05 (0.0020)
Maximum tolerance in journal diameter mm (in)		0.1 (0.0039)
Camshaft end play mm (in)		0.08 to 0.38 (0.0031 to 0.0150)

	Standard	Maximum tolerance
Surface flatness mm (in)	less than 0.05 (0.0020)	0.10 (0.0039)

CYLINDER BLOCK

1. Visually check cylinder block for cracks or flaws.
2. Measure the top of cylinder block (cylinder head mating face) for warpage. If warpage exceeds the limit, correct it.

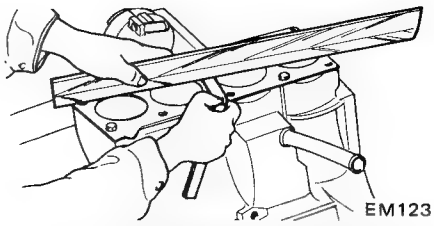


Fig. EM-48 Checking cylinder block surface

3. Using a bore gauge, measure cylinder bore for out-of-round or taper. If, out-of-round or taper is excessive, rebore the cylinder walls by means of a boring machine. Measurement should be taken along bores for taper and around bores for out-of-round. See Figure EM-50.

Out-of-round X-Y
Taper A-B

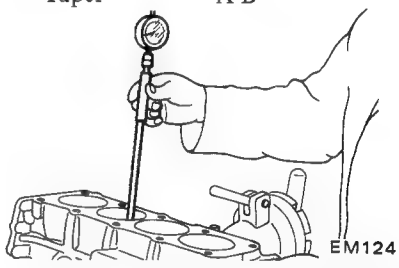


Fig. EM-49 Measuring cylinder bore diameter

4. When wear, taper or out-of-round is minor and within the limit, remove the step at the topmost portion of cylinder using a ridge reamer or other similar tool.

How to measure cylinder bore

A bore gauge is used. Measure cylinder bore at top, middle and bottom positions toward A and B directions as shown in Figure EM-50 and record the measured values.

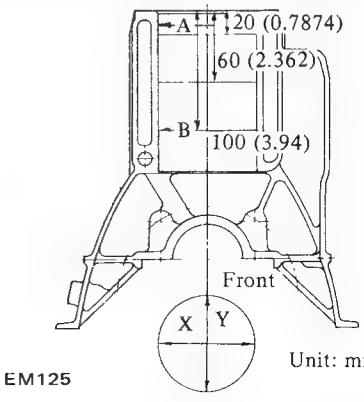


Fig. EM-50 Cylinder bore measuring positions

		Standard		Wear limit
		L16	L18	
Cylinder bore mm (in)	Inner diameter	83.000 to 83.050 (3.2677 to 3.2697)	85.000 to 85.050 (3.3465 to 3.3484)	0.2 (0.0079)
	Out-of-round	0.015 (0.0006)		
	Taper	0.015 (0.0006)		
Difference in cylinder bore mm (in)		0.05 (0.0020)		0.2 (0.0079)

Oversize pistons specifications

	L16	L18
Piston diameter mm (in)		
Standard	82.985 to 83.035 (3.2671 to 3.2691)	84.985 to 85.035 (3.3459 to 3.3478)
0.50 (0.0197) Oversize	83.465 to 83.515 (3.2860 to 3.2880)	85.465 to 85.515 (3.3648 to 3.3667)
1.00 (0.0394) oversize	83.965 to 84.015 (3.3057 to 3.3077)	86.965 to 86.015 (3.4238 to 3.3864)

Cylinder boring

1. When any of cylinders needs boring, all other cylinders must also be bored at the same time.
2. Determine piston oversize according to the amount of wear of cylinder.
3. The size to which cylinders must be honed is determined by adding to the largest piston diameter (at piston skirt in thrust direction) piston-to-cylinder clearance.

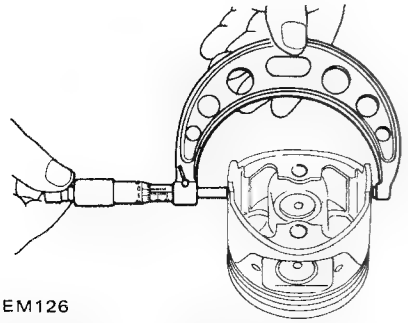


Fig. EM-51 Measuring piston diameter

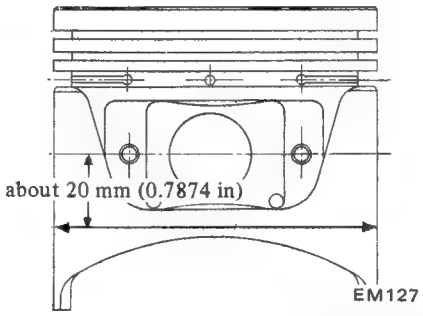


Fig. EM-52 Measuring piston skirt diameter

Rebored size calculation

D = A + B - C = A + [0.005 to 0.025 mm (0.0002 to 0.0010 in)]

Where,

D: Honed diameter

A: Skirt diameter as measured

B: Piston-to-wall clearance

C: Machining allowance (0.02 mm) (0.0008 in)

Note: To prevent strain due to cutting heat, bore the cylinders in the order of 2-4-1-3.

4. Do not cut too much out of cylinder bore at a time, but cut 0.05 mm (0.0020 in) or so at a time.
5. Measurement of cylinder bore just machined requires the utmost care since it is expanded by cutting heat.
6. As a final step, cylinders should be honed to size.
7. Measure the finished cylinder bore for out-of-round or tapered part.
8. Measure piston to cylinder clearance.

This clearance can be checked easily by using a feeler gauge and a spring balance hooked on feeler gauge, measuring the amount of force required to pull out gauge from between piston and cylinder.

Notes:

a. When measuring the clearance, slowly pull the feeler gauge straight upward.

b. It is recommended that piston and cylinder be heated to 20°C (68°F).

		L16 and L18
Standard clearance	mm (in)	0.025 to 0.045 (0.0010 to 0.0018)
Feeler gauge	mm (in)	0.04 (0.0016)
Extracting force	kg (lb)	0.2 to 1.5 (0.44 to 3.31)

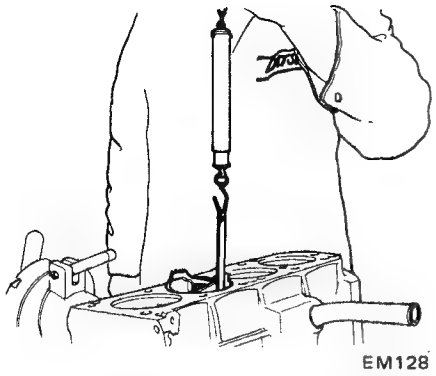


Fig. EM-53 Measuring piston fit in cylinder

Note: If cylinder bore has worn beyond the wear limit, use cylinder liner.
Undersize cylinder liners are available for service.
Interference fit of cylinder liner in cylinder block should be 0.075 to 0.085 mm (0.0030 to 0.0033 in).

Cylinder liner for service

Unit: mm (in)

	L16	
	Outside diameter	Inner diameter
4.0 (0.1575) Undersize	87.00 to 87.05 (3.4252 to 3.4272)	82.50 to 82.60 (3.2480 to 3.2520)
4.5 (0.1772) Undersize	87.50 to 87.55 (3.4449 to 3.4468)	
5.0 (0.1969) Undersize	88.00 to 88.05 (3.4646 to 3.4665)	

4. Push ring into cylinder with a piston so as to place it squarely in cylinder; measure ring gap with a feeler gauge.

Ring should be placed to diameter at upper or lower limit of ring travel.

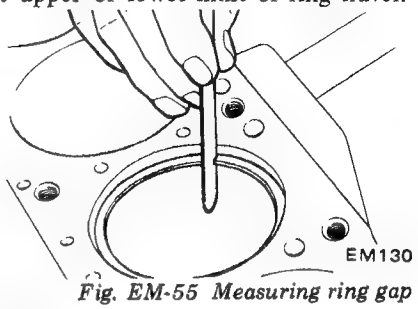


Fig. EM-55 Measuring ring gap

Notes:

a. **When piston ring only is to be replaced, without cylinder bore being corrected, measure the gap at the bottom of cylinder where the wear is minor.**

b. **Oversize piston rings are available for service.**

L16: 0.5 mm (0.0197 in), 1.0 mm (0.0394 in) and 1.5 mm (0.0591 in) oversize.
L18: 0.5 mm (0.0197 in) and 1.0 mm (0.0394 in).

PISTONS, PISTON PINS AND PISTON RINGS

1. Remove carbon from piston and ring grooves with a carbon scraper and a curved steel wire. The wire will be useful in cleaning bottom land of ring groove. Clean out oil slots in bottom land of oil ring groove.
2. Check for damage, scratches and wear. Replace if such a defect is detected.
3. Measure the side clearance of rings in ring grooves as each ring is installed. Clearance with new pistons and rings should be as follows.

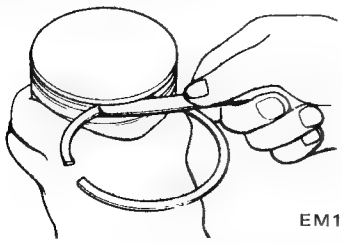


Fig. EM-54 Measuring piston ring side clearance

Side clearance

Unit: mm (in)

	Standard		Wear limit
	L16	L18	
Top ring	0.040 to 0.080 (0.0016 to 0.0031)	0.045 to 0.08 (0.0018 to 0.0031)	0.1 (0.0039)
Second ring	0.030 to 0.070 (0.0012 to 0.0028)	←	
Oil ring	–	–	–

Ring gap

Unit: mm (in)

	Standard		Wear limit
	L16	L18	
Top ring	0.25 to 0.40 (0.0098 to 0.0157)	0.35 to 0.55 (0.0138 to 0.0217)	1.0 (0.0394)
Second ring	0.15 to 0.30 (0.0059 to 0.0118)	0.30 to 0.50 (0.0118 to 0.0197)	
Oil ring	0.3 to 0.9 (0.0118 to 0.0354)	←	

5. Measure piston pin hole in relation to the outer diameter of pin. If wear exceeds the limit, replace such piston pin together with piston on which it is installed.
6. Determine the fitting of piston pin into piston pin hole to such an extent that it can be finger pressed at room temperature. This piston pin must be a tight press fit into connecting rod.

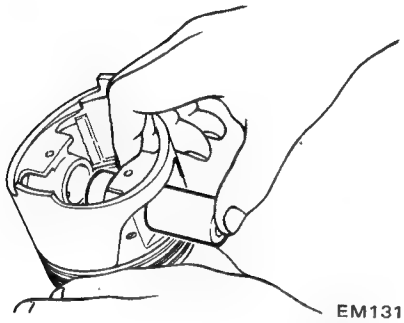


Fig. EM-56 Piston pin fitting

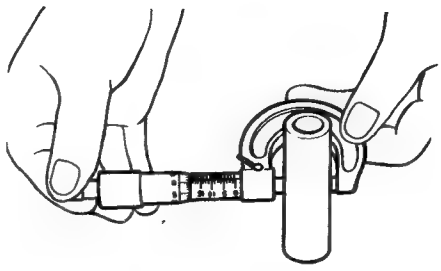


Fig. EM-57 Measuring piston pin diameter

Unit: mm (in)

	L16 and L18
Piston pin outside diameter	20.993 to 20.998 (0.8265 to 0.8266)
Piston pin hole diameter	21.001 to 21.008 (0.8268 to 0.8271)
Piston pin to piston clearance	0.003 to 0.015 (0.0001 to 0.0006)
Interference fit of piston pin to connecting rod	0.015 to 0.033 (0.00059 to 0.00130)

	Model	Standard	Maximum
Connecting rod bend or torsion (per 100 mm or 3.94 in length) mm (in)	L16 L18	0.03 (0.0012)	0.05 (0.0020)

L14, L16 and L18	Standard	Maximum
Big end play mm (in)	0.2 to 0.3 (0.0079 to 0.0118)	0.6 (0.0118)

CONNECTING ROD

1. If a connecting rod has any flaw on both sides of the thrust face and the large end, correct or replace it.

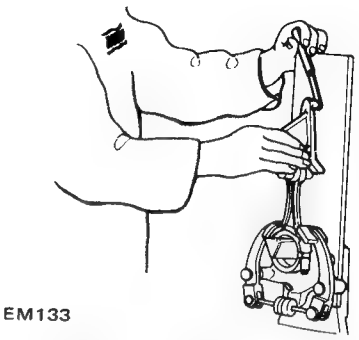


Fig. EM-58 Checking rod alignment

2. Check connecting rod for bend or torsion using a connecting rod aligner. If bend or torsion exceeds the limit, correct or replace.
3. When replacing connecting rod, select rod so that weight difference between new and old ones is within 7 gr (0.25 oz).
4. Install connecting rods with bearings on to corresponding crank pins and measure the thrust clearance. If the measured value exceeds the limit, replace such connecting rod.

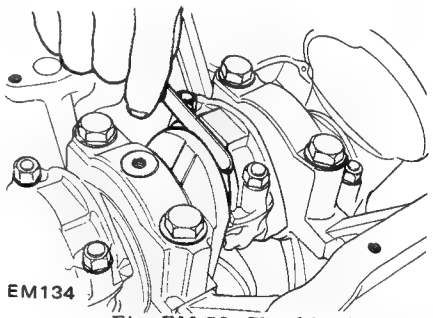


Fig. EM-59 Checking big end play

CRANKSHAFT

1. Whenever crankshaft is removed from engine, it should be cleaned thoroughly in a suitable solvent. After cleaning check crankshaft journal and crank pin for score, bias wear or cracks. Repair or replace as required. If defects are minor, dress with fine crocus cloth.

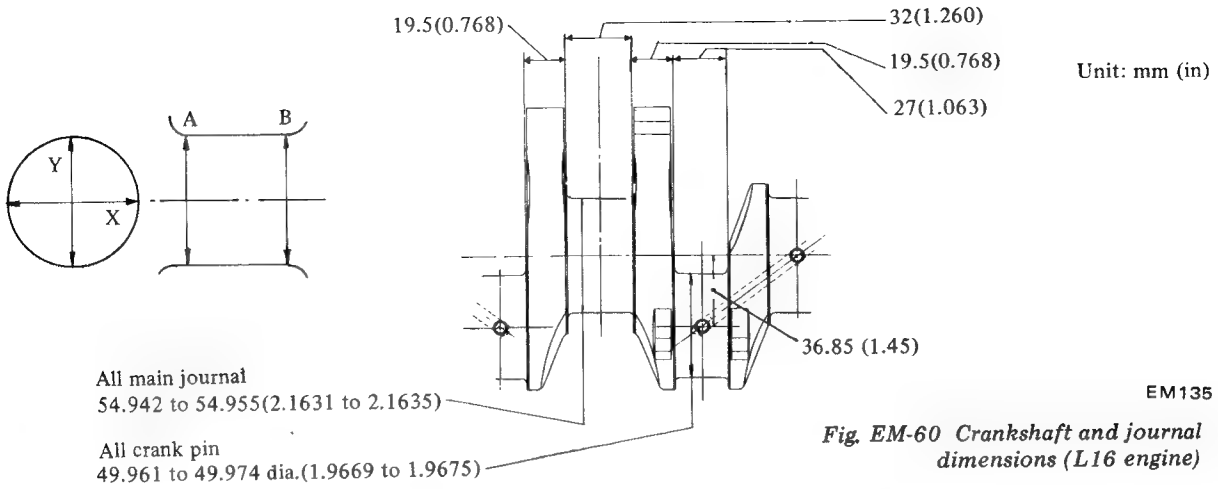


Fig. EM-60 Crankshaft and journal dimensions (L16 engine)

2. Check with a micrometer journals and crank pins for taper and out-of-round. Measurement should be taken along journals for taper and around journals for out-of-round. See Figure EM-60 for detail information.

Out-of-round	X-Y
Taper	A-B

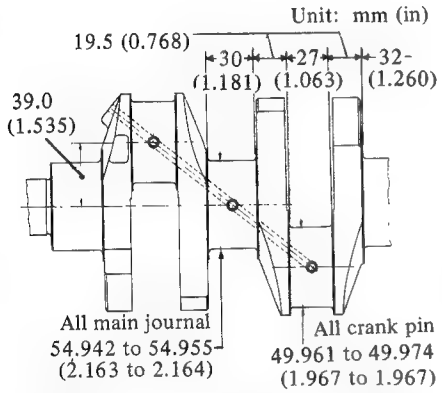


Fig. EM-61 Crankshaft and journal dimensions (L18 engine)

If journals or crank pins are tapered or out-of-round beyond limits, replace with a new shaft.

3. Crankshaft bend can be checked by placing it on V-blocks and using a dial gauge with its indicating finger resting on center journal.

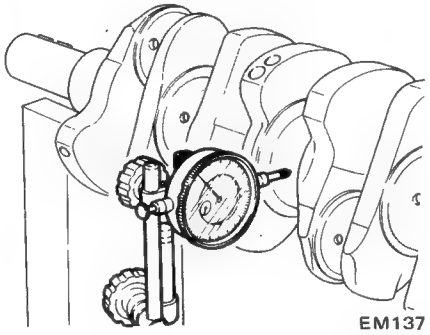


Fig. EM-62 Checking crankshaft bend

Note: When measuring bend, use a dial gauge. Bend value is a half of the reading obtained when crankshaft is turned one full revolution with a dial gauge attached to its center journal.

4. After regrinding crankshaft, finish it to the necessary size indicated in the list on page EM-19 by using an adequate undersize bearing according to the extent of required repair.

5. Install crankshaft in cylinder block and measure crankshaft free end play.

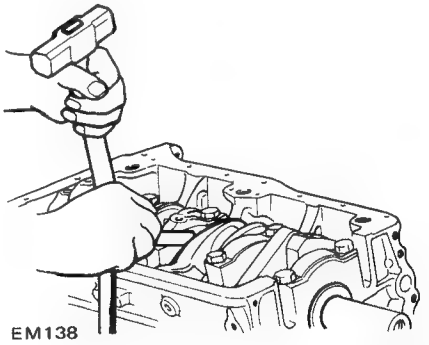


Fig. EM-63 Checking crankshaft end play

L16 and L18	Standard	Maximum
Taper and out-of-round of journal and crank pin mm (in)	less than 0.01 (0.0004)	0.03 (0.0012)

L16 and L18	Standard	Maximum
Crankshaft bend mm (in)	less than 0.05 (0.0020)	0.10 (0.0039)

	Standard	Wear limit
Crankshaft free end play mm (in)	0.05 to 0.18 (0.0020 to 0.0071)	0.3 (0.0118)

6. At the rear end of crankshaft, check crankshaft pilot bushing for wear or damage. Replace it, if any defect is detected.

To replace crankshaft rear pilot bushing, proceed as follows:

(1) Pull out bushing using special tool "Pilot Bushing Puller ST16610001."

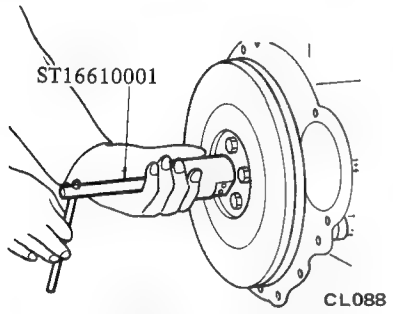


Fig. EM-64 Pulling out pilot bushing

(2) Before installing a new bushing, thoroughly clean bushing hole. Press fit bushing so that its height above flange end is 4.5 to 5.0 mm (0.177 to 0.197 in). Do not oil bushing.

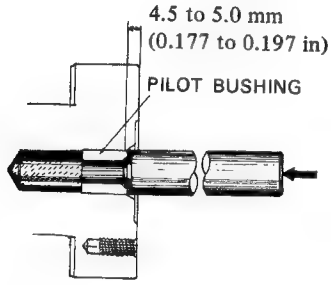


Fig. EM-65 Press-fitting new pilot bushing

BUSHING AND BEARING

Measurement of main bearing clearance

1. Thoroughly clean all bearings and check for scratches, melt, score or wear.

Replace bearings, if any defect is detected.

2. Crankshaft journals and bearings should be clean and free from dust and dirt before oil clearance is measured.

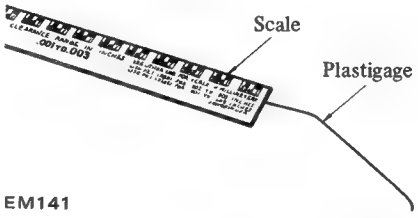


Fig. EM-66 Plastigage

3. Set main bearing on cap block.

4. Cut a plastigage to the width of bearing and place it in parallel with crank pin, getting clear of the oil hole. Install cap on the assembly and tighten them together to the specified torque.

Tightening torque:
4.5 to 5.5 kg-m
(33 to 40 ft-lb)

Note: Do not turn crankshaft while the plastigage is being inserted.

5. Remove cap, and compare width of the plastigage at its widest part with the scale printed in the plastigage envelope.

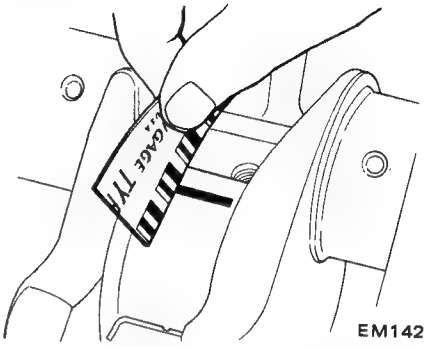


Fig. EM-67 Measuring bearing clearance

Measurement of connecting rod bearing clearance

1. Measure connecting rod bearing clearance in the same manner as above.

Tightening torque:
3.2 to 3.8 kg-m (23 to 28 ft-lb) for L16

4.5 to 5.5 kg-m (33 to 40 ft-lb) for L18

Bearing oil clearance

L16 and L18	Standard	Wear limit
Main bearing clearance mm (in)	0.020 to 0.062 (0.0008 to 0.0024)	0.12 (0.0047)
Connecting rod bearing clearance mm (in)	0.025 to 0.055 (0.0010 to 0.0022)	0.12 (0.0047)

2. If clearance exceeds the specified value, replace bearing with an undersize bearing and grind the crankshaft journal adequately.

Fitting bearings

Bearings are manufactured with crush to make bearings snug down into its bore. To measure this, proceed as follows:

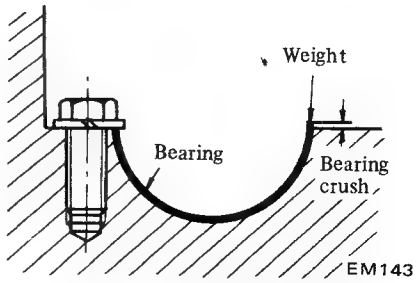


Fig. EM-68 Checking bearing crush

1. Set main bearing in main bearing cap recess or cylinder block bearing recess correctly.
2. Lock the one side end of bearing and press the other side until the bearing back surface touches the recess.
3. Then, measure bearing crush "H" with a feeler gauge. See Figure EM-68. The standard bearing crush value is listed below.
4. Handle connecting rod bearing in the same manner as above.

Bearing crush

	L16 and L18
All main bearing mm (in)	0 to 0.03 (0 to 0.0012)
All connecting rod bearing mm (in)	0.015 to 0.045 (0.0006 to 0.0018)

Main bearing undersize

Unit: mm (in)

L16 and L18	Bearing top thickness	Crank journal diameter
STD	1.822 to 1.835 (0.0717 to 0.0722)	54.942 to 54.955 (2.1631 to 2.1636)
0.25 (0.0098) Undersize	1.947 to 1.960 (0.0767 to 0.0772)	54.692 to 54.705 (2.1532 to 2.1537)
0.50 (0.0197) Undersize	2.072 to 2.085 (0.0816 to 0.0821)	54.442 to 54.455 (2.1434 to 2.1439)
0.75 (0.0295) Undersize	2.197 to 2.210 (0.0865 to 0.0870)	54.192 to 54.205 (2.1335 to 2.1341)
1.00 (0.0394) Undersize	2.322 to 2.335 (0.0914 to 0.0919)	53.942 to 53.955 (2.1237 to 2.1242)

Connecting rod bearing undersize

Unit: mm (in)

	Bearing top thickness	Crank pin diameter
	L16 and L18	L16 and L18
STD	1.493 to 1.506 (0.0588 to 0.0593)	49.961 to 49.974 (1.9670 to 1.9675)
0.06 (0.0024) Undersize	1.523 to 1.536 (0.0600 to 0.0605)	49.901 to 49.914 (1.9646 to 1.9651)
0.12 (0.0047) Undersize	1.553 to 1.566 (0.0611 to 0.0617)	49.841 to 49.854 (1.9622 to 1.9628)
0.25 (0.0098) Undersize	1.618 to 1.631 (0.0637 to 0.0642)	49.711 to 49.724 (1.9571 to 1.9576)
0.50 (0.0197) Undersize	1.743 to 1.756 (0.0686 to 0.0691)	49.461 to 49.474 (1.9473 to 1.9478)
0.75 (0.0295) Unsersize	1.868 to 1.881 (0.00735 to 0.0741)	49.211 to 49.224 (1.9374 to 1.9379)
1.00 (0.0394) Undersize	1.993 to 2.006 (0.0785 to 0.0790)	48.961 to 48.974 (1.9276 to 1.9281)

MISCELLANEOUS COMPONENTS

Crankshaft sprocket, camshaft sprocket

1. Check tooth surface for flaws or wear. Replace sprocket if any defect is found.
2. Install camshaft sprocket in position and check for runout. If it exceeds 0.1 mm (0.0039 in) total indicator reading, replace camshaft sprocket. Also check for end play.

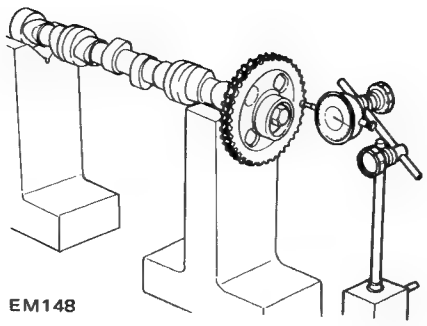


Fig. EM-69 Checking camshaft sprocket runout

L16 and L18	
Camshaft end play mm (in)	0.08 to 0.38 (0.0031 to 0.0150)

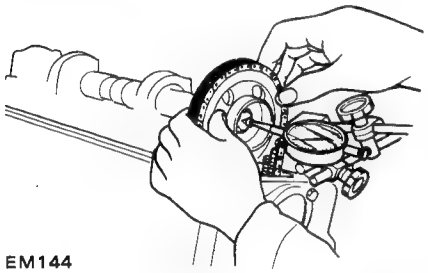


Fig. EM-70 Checking camshaft end play

3. Check chain for damage, excessive wear or stretch at its roller links. Replace a defective chain.
4. When chain stretches excessively, the valve timing goes out of order. On L16 and L18 engines, two location (camshaft set) holes are provided in camshaft sprocket to correct the valve timing.

Adjust camshaft sprocket location. If the stretch of chain roller links is excessive, adjust the camshaft sprocket location by transferring the camshaft set position of camshaft sprocket to No. 3 hole.

1. Turn engine until No. 1 piston is at T.D.C. on its compression stroke. Examine whether camshaft sprocket location notch comes off the left end of the oblong groove on camshaft locate plate. (If the location notch is off the left end of the oblong groove, the stretch of chain is beyond the limit.)

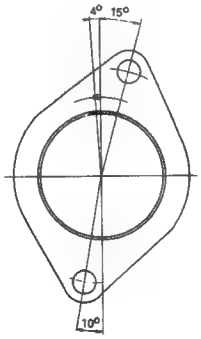


Fig. EM-71 Camshaft locate plate

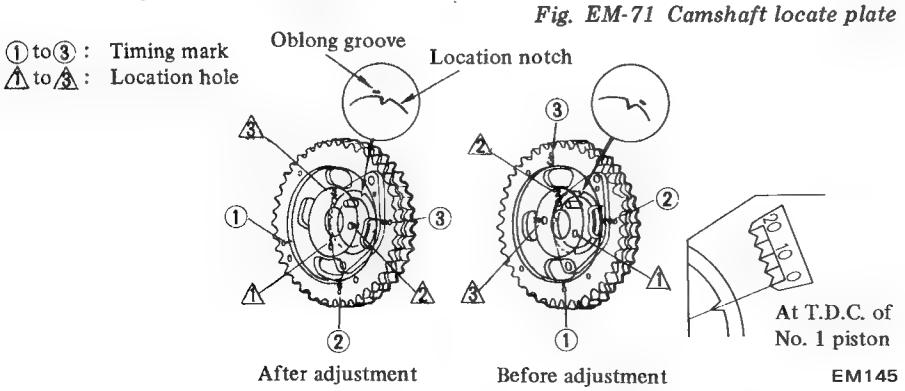


Fig. EM-72 Adjusting camshaft sprocket location

2. Turn engine until No. 1 piston is at T.D.C. on its compression stroke, setting camshaft on No. 3 location hole in camshaft sprocket. Then this No. 3 notch should be on the right end of the oblong groove. When No. 3 hole is used, also No. 3 timing mark has to be used. The amount of the modification is 4° by the rotation of crankshaft.

Note: No. 2 hole is factory adjusted. (No. 1 hole is used for 6 cylinder engine and not for the L16 and L18 engines). Then, if the stretch of chain is beyond the limit, transfer the camshaft sprocket location hole from No. 2 to No. 3.

3. When the modification becomes impossible even by transferring the camshaft location hole, replace chain assembly.

Chain tensioner and chain guide

Check for wear and breakage. Replace if necessary.

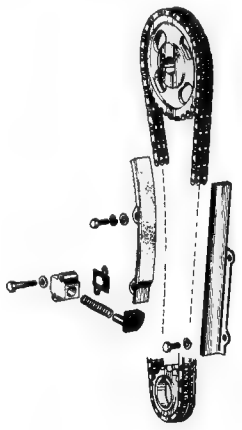


Fig. EM-73 Camshaft drive mechanism

Flywheel

1. Check the clutch disc contact surface with flywheel for damage or wear. Repair or replace if necessary.
2. Measure runout of the clutch disc contact surface with a dial gauge. If it exceeds 0.15 mm (0.0059 in) total indicator reading, replace it.

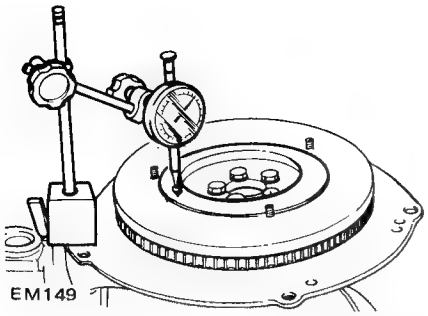


Fig. EM-74 Checking flywheel deviation

3. Check tooth surfaces of ring gear for flaws or wear.

Replace if necessary.

Note: Replace ring gear at about 180° to 220°C (356° to 428°F).

Front cover and rear oil seal

First check front cover and rear oil seal for worn or folded over sealing lip or oil leakage. If necessary, replace with a new seal. When installing a new seal, pay attention to its mounting direction.

Note: It is good practice to renew oil seal whenever engine is overhauled.

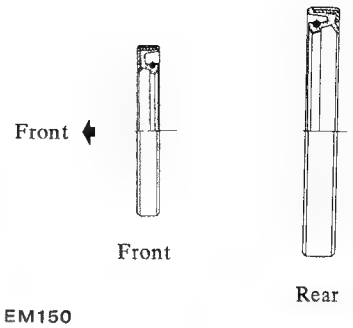


Fig. EM-75 Oil seal of crankshaft

ENGINE ASSEMBLY

CONTENTS

PRECAUTIONS

1. Use thoroughly cleaned parts. Particularly, make sure that oil holes are clear of foreign matter.
2. When installing sliding parts such as bearings, be sure to apply engine oil to them.
3. Use new packings and oil seals.
4. Do not reuse lock washers that have been removed.
5. Keep tools and work benches clean.
6. Keep the necessary parts and tools ready near at hand.
7. Be sure to follow specified tightening torque and order.
8. Applying sealant

Use sealant to eliminate water and oil leaks. Parts requiring sealant are:

(1) Front cover gasket: Front side of cylinder block and cover gasket. See Figure EM-76.

(2) Front cover: Top of front cover, see Figure EM-76.

(3) Main bearing cap and cylinder block: Each side of rear main bearing cap and each corner of cylinder block. See Figure EM-77.

(4) Cylinder block: Step portions at four mating surfaces (cylinder block to front chain cover and cylinder block to rear main bearing cap). See Figure EM-78.

Note: Do not apply sealant too much.

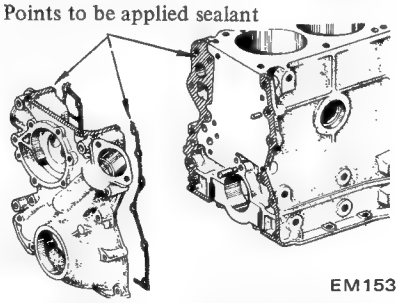


Fig. EM-76 Applying sealant (Front cover and gasket)

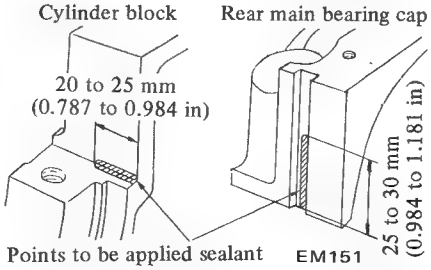


Fig. EM-77 Applying sealant (Main bearing cap and cylinder block)

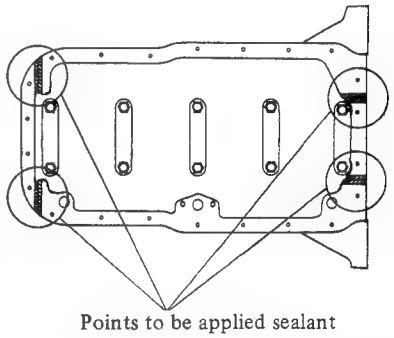


Fig. EM-78 Applying sealant (Cylinder block)

CYLINDER HEAD

1. Valve assembly and valve spring

Using special tool "Valve Lifter ST12070000," set valve spring seat in position, and fit valve guide with oil seal.

Assemble valve in the order shown below: valve, inner and outer valve springs, spring retainer, valve collet and valve rocker guide.

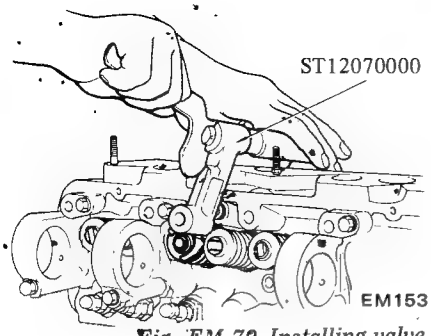


Fig. EM-79 Installing valve

Notes:

a. **Check whether the valve face is free from foreign matters.**
b. **The L16 and L18 engines use double type valve springs.**

2. Valve rocker pivot assembly

Screw valve rocker pivots joined with lock nuts into pivot bushing.

3. Camshaft assembly

Set locating plate and install camshaft in cylinder head carefully. Do not damage the bearing inside. The oblong groove of locating plate must be directed toward the front side of engine.

4. Install camshaft sprocket on camshaft and tighten it together with fuel pump cam to the specified torque.

Tightening torque:
12 to 16 kg-m
(86 to 116 ft-lb)

At this time, check camshaft end play.

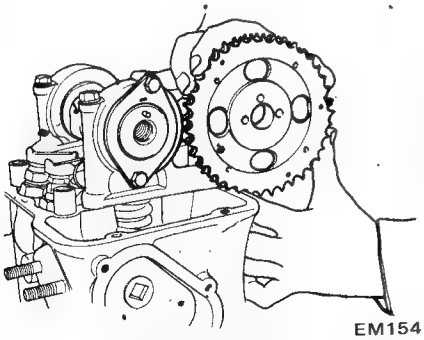


Fig. EM-80 Installing camshaft sprocket

5. Install rocker arms by pressing down valve springs with a screwdriver.
6. Install valve rocker springs.
7. After assembling cylinder head, turn camshaft until No. 1 piston is at T.D.C. on its compression stroke.

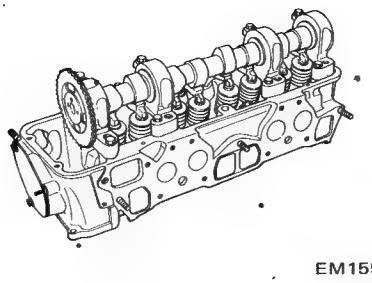


Fig. EM-81 Assembling cylinder head

PISTON AND CONNECTING ROD

1. Assemble pistons, piston pins and connecting rods to the designated cylinder.

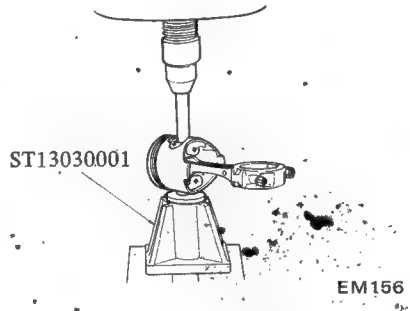


Fig. EM-82 Installing piston pin

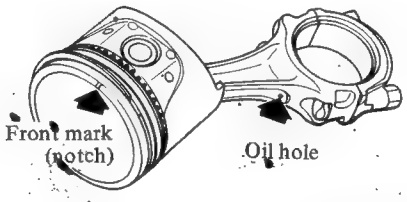


Fig. EM-83 Assembling piston and connecting rod

Notes:

a. **Piston is pressed into connecting rod, and fitting force is 0.5 to 1.5 tons and the aid of special tool "Piston Pin Press Stand ST13030001" is necessary.**
When pressing piston pin in connecting rod, apply engine oil to pin and small end of connecting rod.
b. **Arrange so that oil jet of connecting lod big end is directed toward the right side of cylinder block.**
c. **Be sure to install piston in cylinders with notch mark of piston head toward the front of engine.**

2. Install piston rings

Install top and second rings in right position, with the marked side up.

a. **Top ring is chromium-plated on liner contacting face.**
b. **Second ring has larger taper surface than top ring.**
c. **In the combined oil ring, upper rail is the same as lower one.**

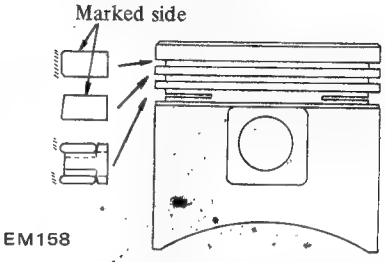


Fig. EM-84 Installing piston ring

3. Fix bearings on connecting rod and connecting rod cap.

Note: Clean the back side of bearing carefully.

ENGINE ASSEMBLY

1. The first step in engine assembly is to bolt special tool "Engine Attachment ST05260001" to right hand side of cylinder block. In succession, install block in another special tool "Engine Stand ST0501S000" with engine bottom up.
2. Set main bearings at the proper portion of cylinder block.

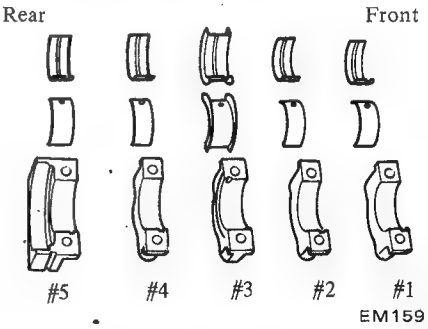


Fig. EM-85 Main bearings

3. Install baffle plate including cylinder block net.

Notes:

a. **Only center bearing (No. 3) is a flanged type.**
b. **All inter-bearings (No. 2 and No. 4) are the same type.**
c. **Front bearing (No. 1) is also the**

same type as rear bearing (No. 5). The difference is that an oil hole is provided in the front bearing.

d. All bearings except No. 1 bearing have an interchangeability between upper and lower bearings.

4. Apply engine oil to main bearing surfaces on both sides of cylinder block and cap.

Install crankshaft.

5. Install main bearing cap and tighten bolts to specified torque.

Tightening torque:
4.5 to 5.5 kg-m
(32.5 to 39.8 ft-lb)

Notes:

a. **Apply sealant to each side of rear main bearing cap and each corner of cylinder block as shown in Figure EM-77.**

b. **Arrange the parts so that the arrow mark on bearing cap faces toward the front of engine.**

c. **Prior to tightening bearing cap bolts, place bearing cap in proper position by shifting crankshaft in the axial direction.**

d. **Tighten bearing cap bolts gradually in separating two to three stages and outwardly from center bearing in the sequence as shown in Figure EM-86.**

e. **After securing bearing cap bolts, ascertain that crankshaft turn smoothly.**

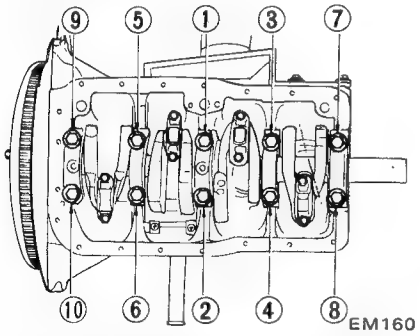


Fig. EM-86 Torque sequence of cap bolts

6. Make sure that there exists proper end play at crankshaft.

Crankshaft end play:
0.05 to 0.18 mm
(0.0020 to 0.0071 in)

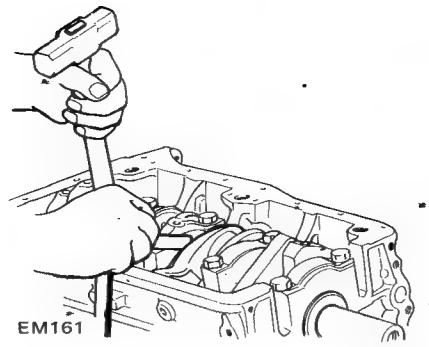


Fig. EM-87 Checking crankshaft end play

7. Install side oil seals into rear main bearing cap. Prior to installing, apply sealant to these seals.

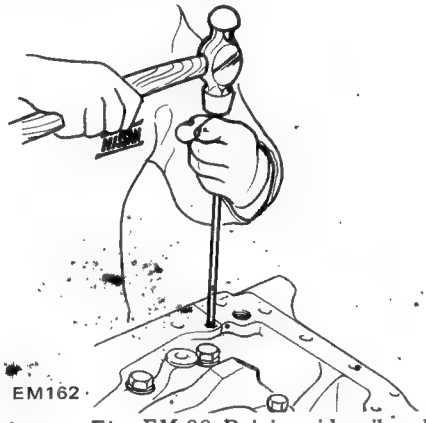


Fig. EM-88 Driving side oil seal

8. Install rear oil seal using special tool "Crankshaft Rear Oil Seal Drift ST15310000." Apply a lithium grease to sealing lip of oil seal.

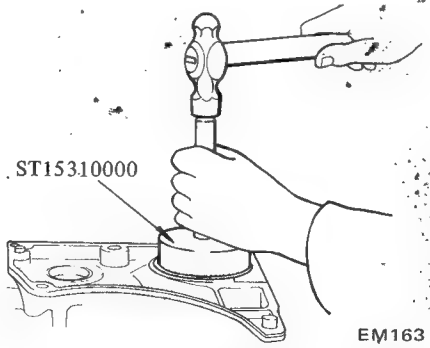


Fig. EM-89 Installing rear oil seal

9. Install rear end plate.

10. Install flywheel securely, and tighten bolts to specified torque.

Tightening torque:
14 to 16 kg-m
(101 to 116 ft-lb)

11. Insert pistons in corresponding cylinder using special tool "Piston Ring Compressor EM03470000."

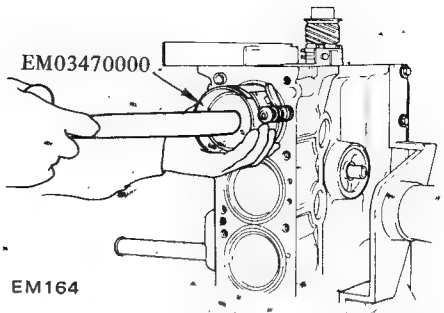


Fig. EM-90 Installing piston-rod assembly

Notes:

a. **Apply engine oil to sliding parts.**

b. **Arrange so that the notch mark on piston head faces to the front of engine.**

c. **Install piston rings at 180° to each other, avoiding their fit in the thrust and piston pin directions.**

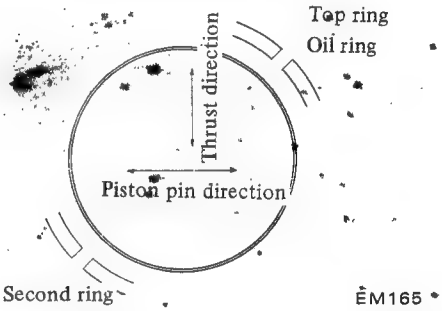


Fig. EM-91 Piston ring direction

12. Install connecting rod caps.

Tightening torque:
3.2 to 3.8 kg-m (23 to 28 ft-lb) for L16
4.5 to 5.5 kg-m (33 to 40 ft-lb) for L18

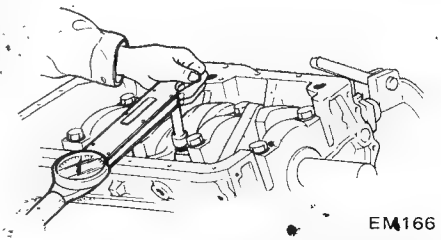


Fig. EM-92 Installing connecting rod cap

Note: Arrange connecting rods and connecting rod caps so that the cylinder numbers face in the same direction.

13. Make sure that there exists proper end play at connecting rod big end.

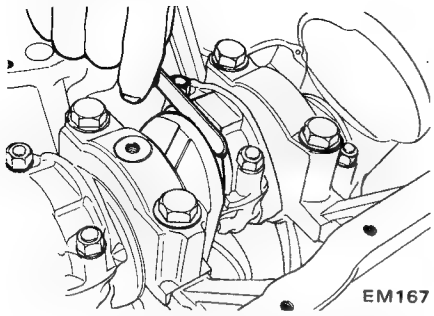


Fig. EM-93 Checking big end play

Big end play:
0.2 to 0.3 mm
(0.0079 to 0.0118 in)

14. Install cylinder head assembly.

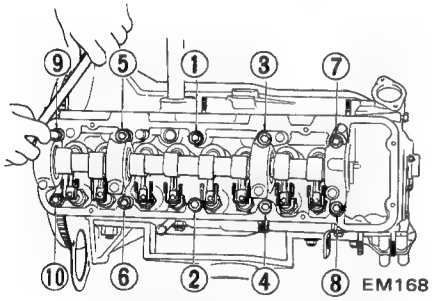


Fig. EM-94 Tightening sequence

(1) Thoroughly clean cylinder block and head surface.

Do not apply sealant to any other part of cylinder block and head surface.

(2) Turn crankshaft until No. 1 piston is at T.D.C. on its compression stroke.

(3) Make sure that camshaft sprocket location notch and plate oblong groove are aligned at their correct positions.

(4) When installing cylinder head, make sure that all valves are apart from heads of pistons.

(5) Do not rotate crankshaft and camshaft separately, because valves will hit heads of pistons.

(6) Temporarily tighten two bolts (①, ②) shown in Figure EM-94.

Tightening torque:
2 kg-m (14.5 ft-lb)

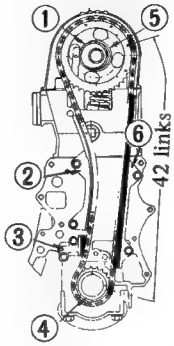
15. Install crankshaft sprocket and distributor drive gear and fit oil thrower.

Note: Make sure that the mating marks of crankshaft sprocket faces to the front.

16. Install timing chain.

Notes:

a. Make sure that crankshaft and camshaft keys point upwards.



1 Fuel pump drive cam
2 Chain guide
3 Chain tensioner
4 Crank sprocket
5 Cam sprocket
6 Chain guide

Fig. EM-95 Installing timing chain

b. Set timing chain by making its mating marks align with those of crankshaft sprocket and camshaft sprocket at the right hand side. There are forty-two chain links between two mating marks of timing chain.

c. No. 2 hole is factory adjusted. When chain stretches excessively, adjust camshaft sprocket at No. 3 hole.

d. Use a set of timing marks and location hole numbers.

17. Install chain guide to cylinder block.

18. Install chain tensioner.

Note: Adjust the protrusion of chain tensioner spindle to 0 mm (0 in).

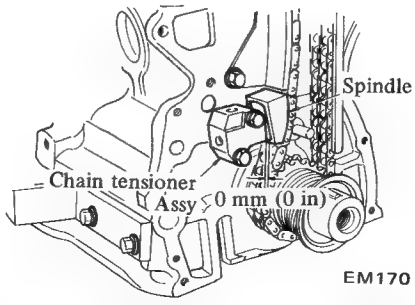


Fig. EM-96 Installing chain tensioner

19. Press new oil seal in front cover. (front cover oil seal should be replaced when front cover is disassembled.)

20. Install front cover with gasket in place.

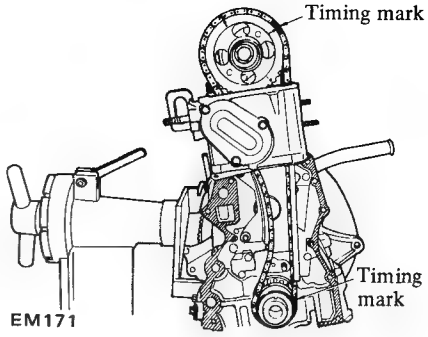


Fig. EM-97 Installing front cover

Notes:

a. Apply sealant to front side of cylinder block and front cover gasket as shown in Figure EM-76.

b. Apply sealant only to the top of front cover as shown in Figure EM-76.

c. Install front cover with head gasket in place.

d. Check the height difference between cylinder block upper face and front cover upper face. Its difference must be less than 0.15 mm (0.0059 in).

e. Note that different types of bolts are used.

f. Apply a lithium grease to sealing lip of oil seal.

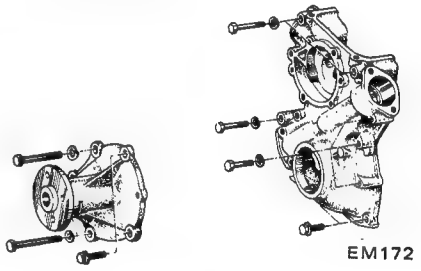


Fig. EM-98 Front cover bolts

Tightening torque:
Size M8
(0.315 in)
1.0 to 1.6 kg-m
(7.2 to 11.6 ft-lb)
Size M6
(0.236 in)
0.4 to 0.8 kg-m
(2.9 to 5.8 ft-lb)

21. Install crankshaft pulley and water pump, then set No. 1 piston at T.D.C. on its compression stroke.

Crankshaft pulley nut
tightening torque:
12 to 16 kg-m
(86.8 to 115.7 ft-lb)

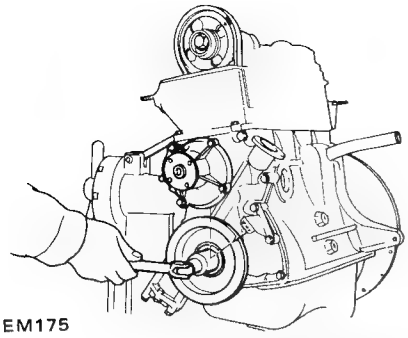

EM175

Fig. EM-99 Installing crankshaft pulley and water pump

22. Finally tighten head bolts to the specified torque in three steps according to the tightening sequence as shown in Figure EM-94.

Note that two types of bolts are used.

Special tool "Cylinder Head Bolt Wrench ST10120000."

Tightening torque:

1st turn
4.0 kg-m (28.9 ft-lb)

2nd turn
6.0 kg-m (43.4 ft-lb)

3rd turn
6.5 to 8.5 kg-m
(47.0 to 61.5 ft-lb)

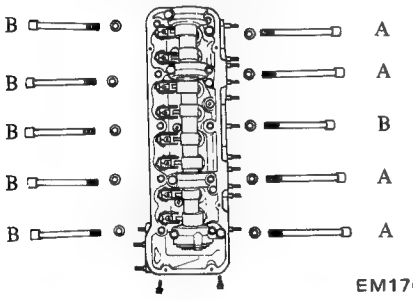


Fig. EM-100 Cylinder head bolts

Notes:

a. Be sure to tighten two small bolts

b. After engine has been operated for several minutes; if necessary, retighten.

23. Install oil pump and distributor driving spindle into front cover.

Tightening torque:
1.1 to 1.5 kg-m
(8.0 to 10.8 ft-lb)

Notes:

a. Assemble oil pump and drive spindle, making driving spindle mark face to oil pump hole.

b. Install oil pump together with drive spindle so that the projection on its top is located in 11 : 25 a.m. position. At this time, the smaller bow-shape will be placed toward the front.

c. Do not forget to install gasket.

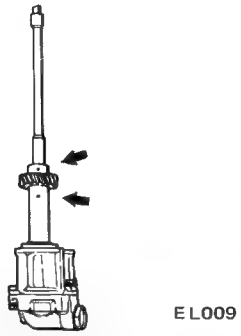

EL009

Fig. EM-101 Setting distributor driving spindle

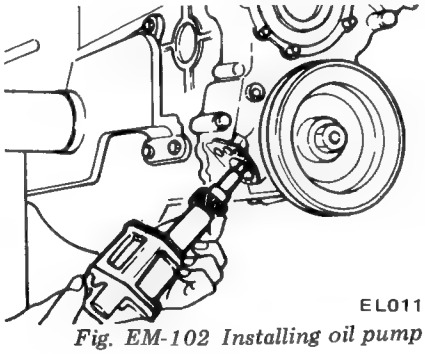

EL011

Fig. EM-102 Installing oil pump

24. Install fuel pump, water inlet elbow and front engine slinger in their positions.

Fuel pump tightening torque:
1.2 to 1.8 kg-m
(8.7 to 13.0 ft-lb)

Note: Do not forget to install fuel pump spacer and packings inserted between spacer and block, spacer and fuel pump.

25. Install oil strainer, oil pan gasket and oil pan.

Notes:

a. Apply sealant to the step portions at four mating surfaces as shown in Figure EM-78.

b. Tightening oil pan should be performed in criss-cross pattern and finally to 0.6 to 0.9 kg-m (4.3 to 6.5 ft-lb) torque.

26. Adjust valve clearance to the specified dimensions.

Special tool "Pivot Adjuster ST10640001."

Tightening torque:
5.0 to 6.0 kg-m
(36.2 to 43.4 ft-lb)

Notes:

a. First set clearance to the cold specifications.

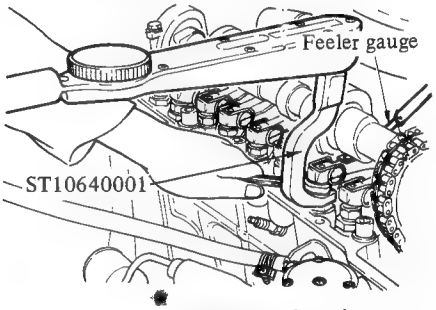


Fig. EM-103 Adjusting valve clearance

b. After engine has been assembled, run it for at least several minutes, finally adjust the clearance to the warm specifications.

27. Install rear engine slinger, exhaust manifold and intake manifold.

Tightening torque:
1.2 to 1.6 kg-m
(8.7 to 11.6 ft-lb)

			L16 and L18
Valve clearance mm (in)	Cold	Intake	0.2 (0.0079)
		Exhaust	0.25 (0.0098)
	Warm	Intake	0.25 (0.0098)
		Exhaust	0.30 (0.0118)

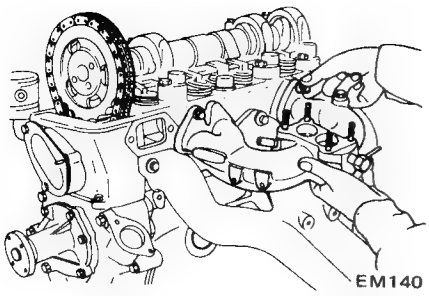


Fig. EM-104 Installing manifolds

28. Install distributor assembly.
29. Install carburetor assembly and carburetor insulator with stamp facing upward. Tightening torque 0.5 to 1.0 kg-m (3.6 to 7.2 ft-lb).
30. Install fuel pipes and vacuum hose.

All pipes and hoses should be clamped securely, being careful not to allow them to interfere with adjacent or surrounding parts.

31. Install thermostat housing, thermostat and water outlet in their positions. Do not forget to install gasket.
32. Install rocker cover.

Note: Bond gasket to rocker cover using sealant. Then, install rocker cover to cylinder head.

33. Install spark plugs.
34. Connect distributor to plug high tension lead wire.
35. Install engine mount bracket on left hand side.
36. Install clutch assembly.

Special tool "Clutch Aligning Bar ST20600000."
Tightening torque:
1.2 to 2.2 kg-m
(8.7 to 15.9 ft-lb)

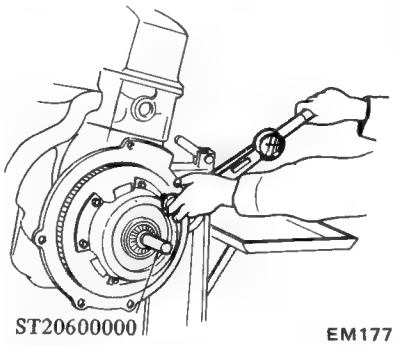


Fig. EM-105 Installing clutch assembly

37. Using an overhead hoist and lifting cable, hoist engine up away from engine stand and then down onto engine carrier. Install alternator bracket, adjusting bar, alternator, fan pulley, fan and fan belt in this order. Then, check to be sure that deflection of fan belt is held within 8 to 12 mm (0.315 to 0.472 in) when thumb pressure is applied midway between pulleys (A pressed force is about 10 kg (22.0 lb)).

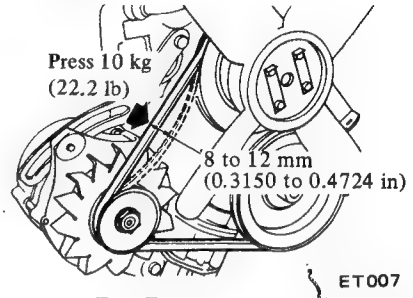


Fig. EM-106 Fan belt tension

38. Install engine mount bracket (right hand), oil filter, oil pressure switch, oil level gauge and water drain plug. When installing an oil filter, fasten it on cylinder block by hand.

Note: Do not overtighten filter, or oil leakage may occur.

39. Power engine oil up to specified level.

SERVICE DATA AND SPECIFICATIONS

GENERAL SPECIFICATIONS

Model		L16	L18
Cylinder arrangement		4, in line	
Displacement	cc (cu in)	1,595 (62.80)	1,770 (108.01)
Bore and stroke	mm (in)	83 x 73.7 (3.2677 x 2.9016)	85 x 78 (3.3465 x 3.0709)
Valve arrangement		O.H.C.	O.H.C.
Firing order		1-3-4-2	1-3-4-2
Engine idle	rpm		
M/T		800	
A/T		650 in "D" range	
Compression ratio		8.5	
Engine idle manifold mmHg (inHg) at idle rpm			
M/T		430 (16.9)	
A/T		390 (15.4) in "N" range	
Oil pressure (Warm at 2,000 rpm)	kg/cm^2 (psi)	3.5 to 4.0 (49.8 to 56.9)	

M/T: Manual Transmission A/T: Automatic Transmission

TIGHTENING TORQUE

Model	L16	L18
Cylinder head bolts kg-m (ft-lb)	2nd Turn 6.0 (43.4)	3rd Turn 6.5 to 8.5 (47.0 to 61.5)
Connecting rod big end nuts kg-m (ft-lb)	3.2 to 3.8 (23 to 27)	4.5 to 5.5 (33 to 40)
Flywheel fixing bolts kg-m (ft-lb)	14 to 16 (101 to 116)	
Main bearing cap bolts kg-m (ft-lb)	4.5 to 5.5 (33 to 40)	
Camshaft sprocket bolt kg-m (ft-lb)	12 to 16 (86.8 to 116)	
Oil pan bolts kg-m (ft-lb)	0.6 to 0.9 (4.3 to 6.5)	
Oil pump bolts kg-m (ft-lb)	1.1 to 1.5 (8.0 to 10.8)	
Oil pan drain plug kg-m (ft-lb)	2.0 to 3.0 (14.5 to 21.7)	
Rocker pivot lock nuts kg-m (ft-lb)	5.0 to 6.0 (36.2 to 43.4)	
Camshaft locating plate bolts kg-m (ft-lb)	0.6 to 0.9 (4.3 to 6.5)	
Carburetor nuts kg-m (ft-lb)	0.5 to 1.0 (3.6 to 7.2)	
Manifold nuts kg-m (ft-lb)	1.2 to 1.6 (8.7 to 11.6)	
Fuel pump nuts kg-m (ft-lb)	1.2 to 1.8 (8.7 to 13.0)	
Crank pulley bolt kg-m (ft-lb)	12.0 to 16.0 (86.8 to 115.7)	

SPECIFICATIONS

Model	L16	L18
a) Valve mechanism		
Valve clearance (Warm) mm (in)	In. 0.25 (0.0098)	Ex. 0.30 (0.0118)
Valve clearance (Cold) mm (in)	In. 0.20 (0.0079)	Ex. 0.25 (0.0098)
Valve head dia. mm (in)		
–Intake	42 (1.6535)	42 (1.6535)
–Exhaust	33 (1.2992)	35 (1.3780)
Valve stem dia. mm (in)		
–Intake	7.965 to 7.980 (0.3136 to 0.3142)	
–Exhaust	7.945 to 7.960 (0.3128 to 0.3134)	

Model		L16	L18
Valve length mm (in)			
	—Intake	114.9 to 115.2 (4.524 to 4.535)	
	—Exhaust	115.7 to 116.0 (4.555 to 4.567)	
Valve lift mm (in)			
	—Intake	10.5 (0.413)	
	—Exhaust	10.5 (0.413)	
Valve spring free length mm (in)			
	—Outer	49.98 (1.968)	
Intake			
	—Inner	44.85 (1.766)	
	—Outer	49.98 (1.968)	
Exhaust			
	—Inner	44.85 (1.766)	
Valve spring pressured length (valve open) mm (in)			
	—Outer	29.5/49.0 (1.161/108)	
Intake			
	—Inner	24.5/25.5 (0.965/56.2)	
	—Outer	29.5/49.0 (1.161/108)	
Exhaust			
	—Inner	24.5/25.5 (0.965/56.2)	
Valve spring assembled height (valve close) mm/kg (in/lb)			
	—Outer	40.0/21.3 (1.575/47.0)	
Intake			
	—Inner	35/12.3 (1.378/27.1)	
	—Outer	40.0/21.3 (1.575/47.0)	
Exhaust			
	—Inner	35.0/12.3 (1.378/27.1)	
Valve spring effective turns mm (in)			
	—Outer	5.0	
Intake			
	—Inner	5.5	

Model		L16	L18
Exhaust	—Outer	5.0	
	—Inner	5.5	
Valve spring wire dia. mm (in)			
Intake	—Outer	4.0 (0.1575)	
	—Inner	2.9 (0.1142)	
Exhaust	—Outer	4.0 (0.1575)	
	—Inner	2.9 (0.1142)	
Valve spring coil dia. mm (in)			
Intake	—Outer	29.4 (1.150)	
	—Inner	21.9 (0.862)	
Exhaust	—Outer	29.4 (1.150)	
	—Inner	21.9 (0.862)	
Valve guide length mm (in)			
	—Intake	59.0 (2.323)	
	—Exhaust	59.0 (2.323)	
Valve guide height from head surface mm (in)		10.6 (0.417)	
Valve guide inner dia. mm (in)			
	—Intake	8.000 to 8.018 (0.3150 to 0.3154)	
	—Exhaust	8.000 to 8.018 (0.3150 to 0.3154)	
Valve guide outer dia. mm (in)			
	—Intake	12.023 to 12.034 (0.4733 to 0.4738)	
	—Exhaust	12.023 to 12.034 (0.4733 to 0.4738)	
Valve guide to stem clearance mm (in)			
	—Intake	0.020 to 0.053 (0.0008 to 0.0021)	

Model		L16	L18
	–Exhaust	0.040 to 0.073 (0.0016 to 0.0029)	
Valve seat width mm (in)			
	–Intake	1.4 (0.0551)	
	–Exhaust	1.3 (0.0512)	
Valve seat angle			
	–Intake	45°	
	–Exhaust	45°	
Valve seat interference fit mm (in)			
	–Intake	0.081 to 0.113 (0.0032 to 0.0044)	
	–Exhaust	0.064 to 0.096 (0.0025 to 0.0038)	
Valve guide interference fit mm (in)		0.027 to 0.049 (0.011 to 0.0019)	
b) Camshaft and timing chain			
Camshaft end play mm (in)		0.08 to 0.38 (0.0031 to 0.0150)	
Camshaft robe lift mm (in)			
	–Intake	7.00 (0.2753)	
	–Exhaust	7.00 (0.2753)	
Camshaft journal dia. mm (in)	–1st	47.949 to 47.962 (1.8877 to 1.8883)	
	–2nd	47.949 to 47.962 (1.8877 to 1.8883)	
	–3rd	47.949 to 47.962 (1.8877 to 1.8883)	
	–4th	47.949 to 47.962 (1.8877 to 1.8883)	
Camshaft bend mm (in)		0.02 (0.0007)	
Camshaft journal to bearing clearance mm (in)		0.038 to 0.067 (0.0015 to 0.0026)	
Camshaft bearing inner dia. mm (in)	–1st	48.000 to 48.016 (1.8898 to 1.8904)	
	–2nd	48.000 to 48.016 (1.8894 to 1.8904)	
	–3rd	48.000 to 48.016 (1.8898 to 1.8904)	
	–4th	48.000 to 48.016 (1.8898 to 1.8904)	
c) Rocker arm lever ratio		1.45	

Model	L16	L18
d) Connecting rod		
Center distance mm (in)	133.0 (5.24)	130.35 (5.132)
Bearing material	F770	
Bearing thickness (S.T.D.) mm (in)	1.493 to 1.506 (0.0588 to 0.0593)	
Big end play mm (in)	0.20 to 0.30 (0.0079 to 0.0118)	
Connecting rod bearing clearance mm (in)	0.025 to 0.055 (0.0010 to 0.0022)	
Connecting rod bend or torsion (per 100 mm or 2.937 in) mm (in)	less than 0.03 (0.0012)	
e) Crankshaft and main bearing		
Journal dia. mm (in)	54.942 to 54.955 (2.1631 to 2.1636)	
Journal taper & out-of-round mm (in)	less than 0.01 (0.0004)	
Crankshaft free end play mm (in)	0.05 to 0.18 (0.0020 to 0.0071)	
Wear limit of dittoed play mm (in)	0.3 (0.0118)	
Crank pin dia. mm (in)	49.961 to 49.974 (1.9670 to 1.9675)	
Crank pin taper & out-of-round mm (in)	less than 0.01 (0.0004)	
Main bearing material	F770	
Main bearing thickness (S.T.D.) mm (in)	1.822 to 1.835 (0.0717 to 0.0722)	
Main bearing clearance mm (in)	0.020 to 0.062 (0.0008 to 0.0024)	
Wear limit of dittoted clearance mm (in)	0.12 (0.0047)	
Crankshaft bend mm (in)	0.05 (0.0019)	
f) Pistion		
Piston dia. –STD mm (in)	82.985 to 83.035 (3.2671 to 3.2691)	84.985 to 85.035 (3.3459 to 3.3478)

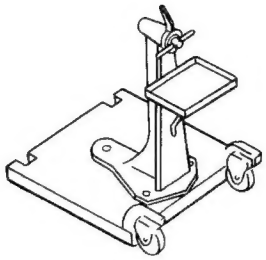
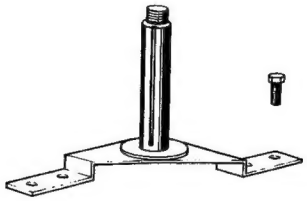
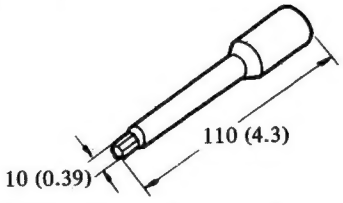
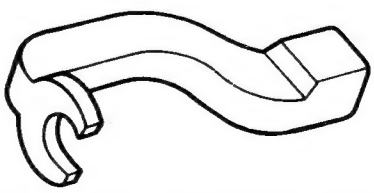
Model		L16	L18
0.50 (0.0197) Oversize		83.465 to 83.515 (3.2860 to 3.2880)	85.465 to 85.515 (3.3648 to 3.3667)
1.00 (0.0394) Oversize		83.965 to 84.015 (3.3057 to 3.3077)	86.965 to 86.015 (3.3844 to 3.3864)
Ellipse difference mm (in)		0.32 to 0.35 (0.013 to 0.014)	
Ring groove width	mm (in)		
	—Top	2.0 (0.0787)	
	—Second	2.0 (0.0787)	
	—Oil	4.0 (0.1575)	
Piston to bore clearance mm (in)		0.025 to 0.045 (0.0010 to 0.0018)	
Piston pin hole off-set mm (in)		0.95 to 1.05 (0.0374 to 0.0413)	
g) Piston pin			
Pin dia. mm (in)		20.993 to 20.998 (0.8265 to 0.8266)	
Pin length mm (in)		72.25 to 73.00 (2.8445 to 2.8740)	
Piston pin to piston clearance mm (in)		0.003 to 0.015 (0.0001 to 0.0006)	
Interference fit of piston pin to connecting rod bushing mm (in)		0.015 to 0.033 (0.0006 to 0.0013)	
h) Piston ring			
Ring height mm (in)	—Top	1.977 to 1.990 (0.0778 to 0.0783)	1.970 to 1.990 (0.0776 to 0.0783)
	—Second	1.977 to 1.990 (0.0778 to 0.0783)	1.970 to 1.990 (0.0776 to 0.0783)
Side clearance mm (in)			
	—Top	0.040 to 0.080 (0.0016 to 0.0031)	0.045 to 0.080 (0.0018 to 0.0031)
	—Second	0.030 to 0.070 (0.0012 to 0.0028)	
Ring gap mm (in)			
	—Top	0.25 to 0.40 (0.0098 to 0.0157)	0.35 to 0.55 (0.0138 to 0.0217)
	—Second	0.15 to 0.30 (0.0059 to 0.0118)	0.30 to 0.50 (0.0118 to 0.0197)
	—Oil	0.30 to 0.90 (0.0118 to 0.0354)	0.30 to 0.90 (0.0118 to 0.0354)

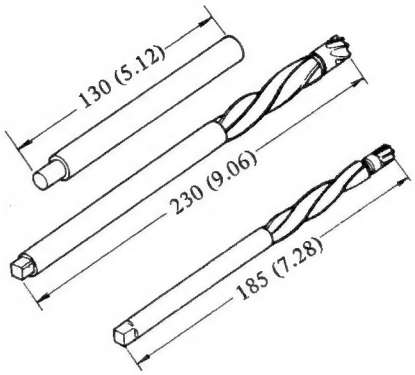
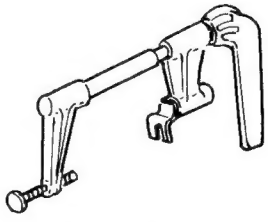
TROUBLE DIAGNOSES AND CORRECTIONS

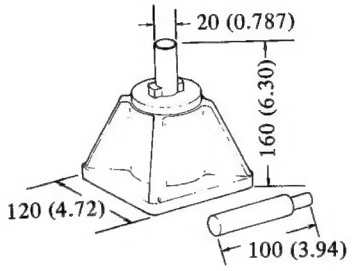
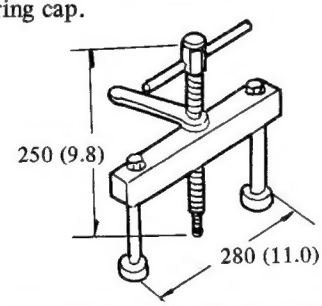
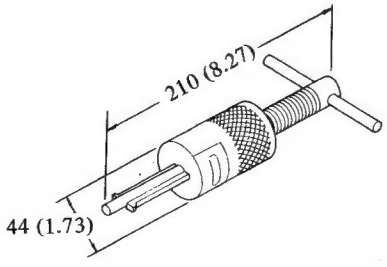
Condition	Probable cause	Corrective action
I. Noisy engine		
Knocking of crankshaft and bearing.	Loose main bearing.	Replace.
	Seized bearing.	Replace.
	Bent crankshaft.	Repair or replace.
	Uneven wear of journal.	Correct.
	Excessive crankshaft end play.	Replace center bearing.
Piston and connecting rod knocking	Loose bearing.	Replace.
	Seized bearing.	Replace.
	Loose piston pin.	Replace pin or bushing.
	Loose piston in cylinder.	Recondition cylinder.
	Broken piston ring.	Replace.
	Improper connecting rod alignment.	Realign.
Camshaft knocking	Loose bearing.	Replace.
	Excessive axial play.	Replace bearing thrust plate.
	Rough gear teeth.	Repair.
	Broken cam gear.	Replace.
Timing chain noise	Improper chain tension.	Adjust.
	Worn and/or damaged chain.	Replace.
	Worn sprocket.	Replace.
	Worn and/or broken tension adjusting mechanism.	Replace.
	Excessive camshaft and bearing clearance.	Replace.
Camshaft and valve mechanism knocking	Improper valve clearance.	Adjust.
	Worn adjusting screw.	Replace.
	Worn rocker face.	Replace.
	Loose valve stem in guide.	Replace guide.
	Weakened valve spring.	Replace.
	Seized valve.	Repair or replace.
Water pump knocking	Improper shaft end play.	Replace.
	Broken impeller.	Replace.
II. Other mechanical troubles		
Sticked valve	Improper valve clearance.	Adjust.
	Insufficient clearance between valve stem and guide.	Clean stem or ream guide.
	Weakened or broken valve spring.	Replace.
	Biting or damage of valve stem.	Replace or clean.
	Poor quality of fuel.	Use good fuel.

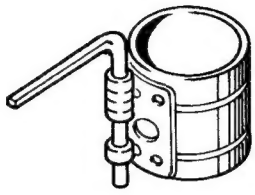
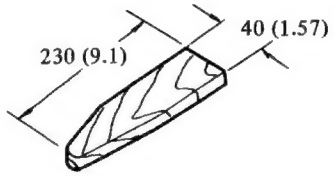
Condition	Probable cause	Corrective action
Seized valve seat	Improper valve clearance.	Adjust.
	Weakened valve spring.	Replace.
	Thin valve head edge.	Replace valve.
	Narrow valve seat.	Reface.
	Overheat.	Repair or replace.
	Over speeding.	Drive under proper speed.
	Sticked valve guide.	Repair.
Excessively worn cylinder and piston	Shortage of engine oil.	Add or replace oil.
	Dirty engine oil.	Clean crankcase, replace oil and oil filter element.
	Poor quality of oil.	Use right oil.
	Overheat.	Repair or replace.
	Wrong assembly of piston with connecting rod.	Repair or replace.
	Improper piston ring clearance.	Adjust.
	Broken piston ring.	Replace.
	Dirty air cleaner.	Clean.
	Mixture too rich.	Adjust.
	Engine over run.	Drive at proper speeds.
	Sticked choke valve.	Clean and adjust.
	Overchoking.	Start correct way.
Defective connecting rod	Shortage of engine oil.	Add oil.
	Low oil pressure.	Correct.
	Poor quality of engine oil.	Use right oil.
	Rough surface of crankshaft.	Grind and replace bearing.
	Clogged oil passage.	Clean.
	Wear or eccentricity of bearing.	Replace.
	Wrong assembly of bearing.	Correct.
	Loose bearing.	Replace.
	Connecting rod alignment incorrect.	Repair or replace.
Defective crankshaft bearing	Shortage of engine oil.	Add or replace.
	Low oil pressure.	Correct.
	Poor quality of engine oil.	Use right oil.
	Crankshaft journal worn or out-of-round.	Repair.
	Clogged oil passage in crankshaft.	Clean.
	Wear or eccentricity of bearing.	Replace.
	Wrong assembly of bearing.	Correct.
	Eccentric crankshaft or bearing.	Replace.

SPECIAL SERVICE TOOL

No.	Tool number & tool name	Description Unit: mm (in)	For use on	Reference page or figure No.
1.	ST0501S000 Engine stand assembly ├ST05011000 Engine stand └ST05012000 Base	This engine stand assembly is used for disassembling or assembling engine block or differential carrier throughout 360° in all directions.  SE184	All models	Fig. EM-11 Page EM-22
2.	ST05260001 Engine attachment	This engine attachment is installed to engine stand ST0501S000 in disassembling or assembling engine.  SE185	L16 L18	Page EM-22
3.	ST10120000 Cylinder head bolt wrench	Special hollow set bolts are used in tightening cylinder heads in L-series engines. This wrench is used to torque cylinder head bolts and its head can be inserted into the torque wrench.  SE186	All L-series	Fig. EM-15 Page EM-25
4.	ST10640001 Pivot adjuster	This tool is used together with a torque wrench in tightening pivot lock nut for valve clearance adjustment.  SE187	All L-series	Fig. EM-103

No.	Tool number & tool name	Description Unit: mm (in)	For use on	Reference page or figure No.
5.	ST1103S000 Valve guide reamer set - ST11031000 Reamer (12.2 mm dia.) - ST11032000 Reamer (8.0 mm dia.) - ST11033000 Drift	This guide is used for: o Pressing used guide out of place. o Driving a new guide into place. o Finishing the bore of new guide.  SE192	All L-series	Fig. EM-41
6.	ST11650001 Valve seat cutter set	This valve seat cutter set is used to or refinish a valve seat.  SE193	All L-series	Fig. EM-42
7.	ST12070000 Valve lifter	This tool is used to compress valve spring by the combined action of its cam and lever, thereby facilitating the removal or installation of collect (for general use).  SE194	All models	Fig. EM-29 Page EM-21 Fig. EM-79

No.	Tool number & tool name	Description Unit: mm (in)	For use on	Reference page or figure No.
8.	ST13030001 Piston pin press stand	This tool is used with a press to drive pin into, or out of, connecting rod.  SE188	All L-series	Fig. EM-26 Fig. EM-82
9.	ST15310000 Crankshaft rear oil seal drift	This tool is used to push a lip type rear oil seal for L-series engine into place by giving hammer blows.  SE189	All L-series	Fig. EM-89
10.	ST1651S000 Crankshaft main bearing cap puller ST16511000 Body ST16512001 Adapter	This tool is used to remove the cap from main bearing. When using this tool, turn its adapter into the threaded hole in main bearing cap.  SE190	All L-series	Fig. EM-22
11.	ST16610001 Pilot bush puller	This tool is used to push pilot bush out of place.  SE191	L16 L18	Fig. EM-64

No.	Tool number & tool name	Description Unit: mm (in)	For use on	Reference page or figure No.
12.	EM03470000 Piston ring compressor	This tool is used to compress piston rings while piston is being inserted into cylinder.  SE199	All models	Fig. EM-90
13.	ST17420001 Chain stopper	This tool is used to prevent chains from falling out of place in removing cylinder heads or cam gears and shafts.  SE195	All L-series	Fig. EM-16